AD-A049 786 STANFORD RESEARCH INST MENLO PARK CALIF F/G 9/2
ALTERNATIVE AUTOMATED DATA PROCESSING SYSTEM CONCEPTS FOR SUPPO--ETC(U)
JUN 77 L S PETERS, K R AUSICH, J H WILLETT N00014-76-C-0582
UNCLASSIFIED NL

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Naval Warfare Research Center *June 1977*

Final Report

ALTERNATIVE AUTOMATED DATA PROCESSING SYSTEM CONCEPTS FOR SUPPORT OF THE FMF (1980-1990)

Volume V: Cost Analysis for Alternative ADPS Concepts

By: L. S. PETERS, K. R. AUSICH, and J. H. WILLETT

Prepared for:

COMMANDANT OF THE MARINE CORPS
HEADQUARTERS MARINE CORPS
WASHINGTON, D.C. 20380
AND
OFFICE OF NAVAL RESEARCH (CODE 230)
DEPARTMENT OF THE NAVY
ARLINGTON, VIRGINIA 22217

CONTRACT N00014-76-C-0582

SRI Project 4950

STANFORD RESEARCH INSTITUTE
Menlo Park, California 94025 · U.S.A.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle)

(6) ALTERNATIVE AUTOMATED DATA PROCESSING SYSTEM CONCEPTS FOR SUPPORT OF THE FMF (1980-1990). VOLUME V. Cost Analysis for Alternative ADPS Concepts.

5. TYPE OF REPORT & PERIOD COVERED

(9) FINAL REPORT.

6. PERFORMING ORG. REPORT NUMBER

SRI Project 4950

7. AUTHOR(s)

(10) L. S. Peters, K. R. Ausich, J. H. Willett

8. CONTRACT OR GRANT NUMBER(s)

(15) N00014-76-C-0582

9. PERFORMING ORGANIZATION NAME AND ADDRESS

Stanford Research Institute
333 Ravenswood Avenue
Menlo Park, California 94025

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS

Commandant of the Marine Corps
Headquarters, U.S. Marine Corps
Washington, D.C. 20380

(11) 12. REPORT DATE: Jun 77

13. NO. OF PAGES: 106

15. SECURITY CLASS. (of this report)

UNCLASSIFIED

(12) 100 p.

14. MONITORING AGENCY NAME & ADDRESS (if diff. from Controlling Office)

Office of Naval Research (Code 230)
Department of the Navy
Arlington, Virginia 22217

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this report)

Approved for public release
Distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

ADP systems, Marine Corps
Automated data processing
Military computers
Information processing
ADP requirements

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This document is one volume of a five volume final report that describes the results of a study effort to identify alternative ADP concepts for the Fleet Marine Force (FMF) during the 1980s. The focus of the study was the administrative type of information processing associated with the management of manpower, operations, and logistics activities of the FMF rather than the tactical control activities. The goal of the study was to define alternative ADP concepts that

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EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

332 500 p. Hw

19. KEY WORDS (Continued)

20 ABSTRACT (Continued)

could serve the FMF's needs in garrison, afloat, and within a combat area. A systematic analysis approach was employed that analyzed requirements, ADP technology, ADP system architectures, operational effectiveness, and system cost. The individual volumes of the final report are titled: Volume I: Study Overview and Results; Volume II: FMF Information Processing Requirements; Volume III: ADPS Technology Estimate for the 1980s; Volume IV: Description and Analysis of Alternative ADPS Concepts; Volume V: Cost Analysis for Alternative ADPS Concepts.

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CONTRACT N00014-76-C-0582

SRI Project 4950

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PREFACE

This volume is part of the final report of SRI Research Project No. 4950, entitled "Alternative Automated Data Processing System Concepts for Support of the FMF (1980-1990)."* SRI initiated this 20-month study in November 1975 for Headquarters, U.S. Marine Corps under Contract No. N00014-76-C-0582 from the Office of Naval Research. HQMC project management was initially provided by the Information Systems Support and Management Division, now a part of the Command, Control, Communications, and Computer Systems Division.

The study followed the approach described in the SRI Study Plan, "Alternative Automated Data System Concepts for Support of the FMF (1980-1990)," dated 1 January 1976--as approved and modified by CMC letter RDS/ISMS-11-pmb 5230/1 dated 26 Mar 76.

This is Volume V of the final report which consists of five volumes whose titles are:

Volume I: Study Overview and Results

Volume II: FMF Information Processing Requirements

Volume III: ADPS Technology Estimate for the 1980s

Volume IV: Description and Analysis of Alternative ADPS Concepts

Volume V: Cost Analysis for Alternative ADPS Concepts.

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*As defined by governing Marine Corps documents, an automated data processing system (ADPS) is an interacting assembly of procedures, processes, methods, personnel, communications, and automatic data processing equipment (ADPE) for performing a series of data processing operations--a combination of automatic data processing resources and automated data systems. An automated data system (ADS) is an assembly of procedures, processes, methods, routines, or techniques (including but not limited to computer programs) united by some form of regulated interaction to form an organized whole, specifically designed to make use of ADPE.

Volume I describes the research objectives and provides an overview of the entire project, along with a comprehensive study bibliography. It also includes an Executive Summary.

Much of the material contained in these volumes was published previously in draft form during the course of the project as SRI Technical Notes. However, the material has been revised and reissued in the final report, which supersedes all the previously published interim and draft material.

I INTRODUCTION

As part of its analysis of alternative ADPS concepts, SRI developed and exercised a computer model for estimating the life cycle cost of the separate alternative concepts. This volume describes the approach taken in the development of the cost model, and contains the detailed documentation of the life cycle cost (LCC) for three alternative ADPS concepts: BASELINE, DISHIER, and DISACT.*

The detailed LCC descriptions for the alternative ADPS concepts are presented in Sections II, III, and IV. The purpose of this section is to define an ADPS cost element structure and to describe its elements, to introduce the format and content of the computer model output, and to briefly describe the approach SRI used to collect cost data and to formulate the LCC estimates. Following Section IV are two appendices. The first addresses SRI's estimate of the specialized training required of Marine Corps personnel to operate and maintain future ADPS. The second briefly addresses the potential cost differential in the LCC of DISHIER and DISACT if "commercial" ADPE were substituted for "ruggedized" or "militarized" ADPE.

A. ADPS Cost Element Structure

A principal task of the SRI effort was the development of a cost element structure that categorizes ADPS costs from concept formulation through system phaseout. A work breakdown structure specifically for ADPS has not as yet been formalized by the Department of Defense; therefore, SRI developed its own structure based on the guidelines of general DoD cost analysis instructions.[1,2,3]†

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*A detailed description of each of these alternatives is contained in Volume IV of this report.

†All references are listed at the end of this report.

The cost element structure is essential because it provides an organized list of cost elements that establishes the relationships among various cost parameters, as well as the total ADS concept cost. It defines the hierarchy and time scheduling of expenditures required for application of the cost model. Finally, it provides a mechanism for comparing important hardware, software, and manpower component costs at various stages in the ADPS life cycle.

The cost element structure is, however, only valuable when it is complemented with good, consistent data. For this reason, SRI has examined the general availability of cost data to ascertain its influence. The problem that surfaced was that the costs have to be estimated for rather loosely defined system configurations--a common occurrence for systems in the conceptual stage. Hence, detailed costs had to be avoided. SRI has taken care to assure that the separate cost elements included in the cost element structure are described to a degree of detail that is compatible with the description of the alternatives that were generated.

SRI's cost element structure consists of three major cost categories: (1) development costs, (2) investment costs, and (3) operating costs. Estimated over the lifetime of the ADPS, the costs included in these categories encompass the total system expenditure.

Development costs are nonrecurring expenditures for resources spent during system research and development. This activity is carried out to develop the ADPS to a point where it can be introduced into the operational inventory with confidence that it will meet reliability and performance specifications. Included in this cost category are the following cost elements:

- System research
- Engineering development
- Prototype systems
- Software development
- System documentation
- System test and evaluation
- Training
- Materiel support.

Investment costs are nonrecurring expenditures that are required to purchase and introduce the ADPS into the operational inventory. Investment costs include the following cost elements:

- ADPE procurement
- System software development
- Software development
- TEMPEST security
- System documentation
- File conversion
- Facilities activation
- Training
- Materiel support.

Once the ADPS becomes operational, there will be recurring expenditures required on an annual basis to operate and maintain the system throughout its useful lifetime. Operating costs include the following cost elements:

- System management and operations
- ADPE maintenance
- Software maintenance
- Documentation
- Facilities support
- Training
- Materiel support
- Communications.

1. Development Cost Elements

Development costs are nonrecurring costs associated with the research and development activities that must be performed to formulate and select system concepts; specify system components and procedures; design/develop ADPE components, software, and system configurations; and test and evaluate prototype system configurations prior to their being procured in quantity and introduced to the field as operational systems. Development cost elements are shown in Figure 1 and described in the following paragraphs.

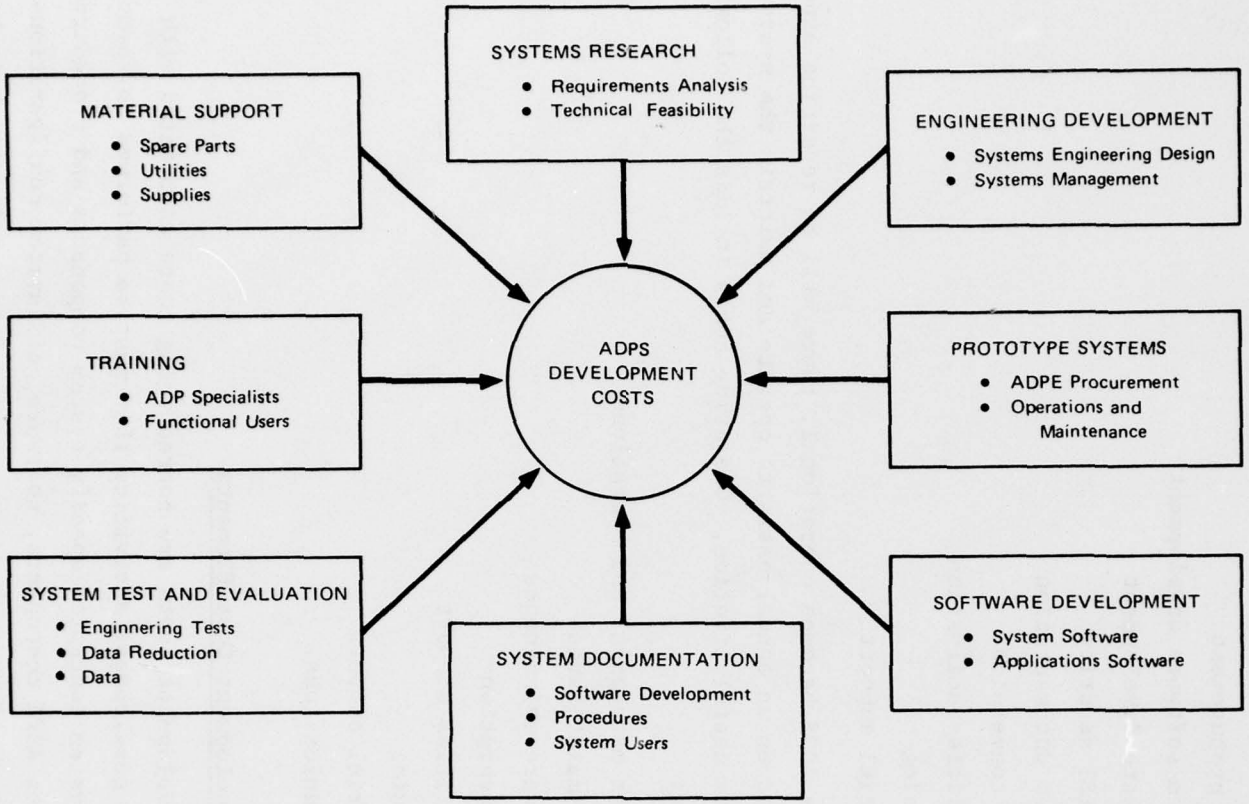

FIGURE 1 ADPS DEVELOPMENT COST ELEMENTS

a. Systems Research

Systems research costs primarily reflect personnel costs associated with the analysis effort that supports the formulation of system concepts and procedures. Significant activities include requirements analyses (or functional analyses) to describe in detail the operations and users needing ADPS support; operations analyses to measure the ADPS performance requirements; and technical analyses to establish ADPE capabilities and constraints.

This cost element includes the research and analysis necessary to establish ADPS feasibility, to select among alternative approaches, and to initiate preliminary design specifications. Personnel who perform this work include operations analysts, information systems analysts, and systems engineers.

b. Engineering Development

Engineering development costs primarily reflect personnel costs associated with the systems engineering and management activities necessary to design and field an ADPS. Major portions of the systems' engineering costs are expended for ADPE system engineering to develop the detailed technical design of the system; information system engineering to develop the interface between the detailed user requirements and the efficient allocation of ADPS resources; data base management (design and maintenance); and software specification. Major portions of the systems management cost are expended for engineering program control, program administration, and contractor monitoring.

This cost element includes the engineering and systems' integration effort necessary to achieve a complete systems design and to exercise a prototype system configuration. Personnel who perform this work include systems engineers, information systems specialists, and senior ADPS managers.

c. Prototype Systems

Prototype systems costs reflect both the cost of assembling, procuring, or leasing prototype ADPE and software configuration (or configurations) and the cost of the ADP personnel required to exercise, operate, and maintain that configuration during its test and evaluation.

d. Software Development

Software development costs primarily reflect the costs of personnel who perform the specification writing, coding, and debugging of both the system software and applications software required to build the initial suite of software. They also include, to a lesser degree, purchased software. Major portions of the software development costs are expended for the systems software (operating systems, data base management systems, compilers, and system utilities); applications programs in the various functional areas (inventorying, finance, scheduling, report generating, and so on); communications system software; system integration and assembly of all the software; and software documentation.

This cost element includes the total implementation of ADS from analysis and specification writing based on user requirements to the final checkout and system integration. Personnel who perform this work include analyst/programmers, systems programmers, and information system specialists.

e. System Documentation

System documentation costs primarily reflect materiel, supply, and distribution costs associated with building the base of stored information that supports the development of the ADPE, software, and procedures concepts for the prototype ADPS configuration. Major portions of this cost are expended for updating, revising, and/or creating ADS documentation (applications programs, data elements, data base administration); maintenance reference manuals; user manuals; and procedures documentation (programming instructions, operations instructions, user instructions, and maintenance instructions).

This cost element includes the initial documentation that supports the initial software development, the prototype ADPE, and the prototype ADPS configuration involved in the technical and operational evaluation process.

f. System Test and Evaluation

System test and evaluation costs primarily reflect personnel costs associated with the development tests, technical evaluation, and operational evaluation of the prototype configuration. They also include the cost of material resources, special equipments, and analysis tools that support the testing. Major portions of this cost are expended for test planning, test conduct, data collection, and data reduction.

This cost element includes the effort that must be expended to examine and verify the reliability and performance of the prototype system configuration from both technical and operational perspectives. Personnel who perform this work include ADP engineers, systems analysts and operations analysts.

g. Training

Training costs are primarily personnel costs associated with providing special instruction for operations and maintenance of ADP resources in general, as well as for support of specific ADPS configurations. Major portions of this cost are expended for instructors' costs and course management costs (training plans, instruction manuals, class lectures, hands-on user experience with ADPE).*

This cost element includes both the training required for ADP professionals (analyst/programmers, systems programmers, operators, and maintenance personnel) and for ADP users (primarily non-ADP oriented

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*The salary and burden of trainees are not included in the training cost here because SRI has selected an annual billet cost as the man-year expenditure, and this billet cost includes the total yearly salary and burden for the trainees.

managers and data collectors). Personnel who perform this work include computer science professionals and ADPE systems specialists.

h. Materiel Support

Materiel support costs primarily reflect supplies, consumables, and services costs associated with the operations and maintenance of the ADPE and the exercise of the ADS. Major portions of this cost are expended for prototype spare parts and repair parts, communications resources, ADP supplies and rentals (computer paper, tapes, disks), utilities (light, air conditioning or heat), special test equipment, and special maintenance equipment.

2. Investment Cost Elements

Investment costs are nonrecurring costs associated with the procurement of ADPE; the procurement of software; the development and documentation of new software; the conversion of existing files to new files; the activation of ADPS facilities; initial training; and the procurement of initial spares and repair parts. They represent the major one-time outlay of resources that results from the decision to field the ADPS configuration developed in the development phase. Investment cost elements are shown in Figure 2 and described in the following paragraphs.

a. ADPE Procurement

ADPE procurement costs primarily reflect the costs of purchasing computers, computer related equipment, and support equipment to make the ADPS operational at each of its intended sites. Major portions of this cost are expended for computers, auxiliary memory storage equipment, input/output devices, and communications equipment.

b. System Software Procurement

System software procurement costs primarily reflect the costs of purchasing ADPE compatible system software and applications software packages to fulfill specific user functions. Major portions of

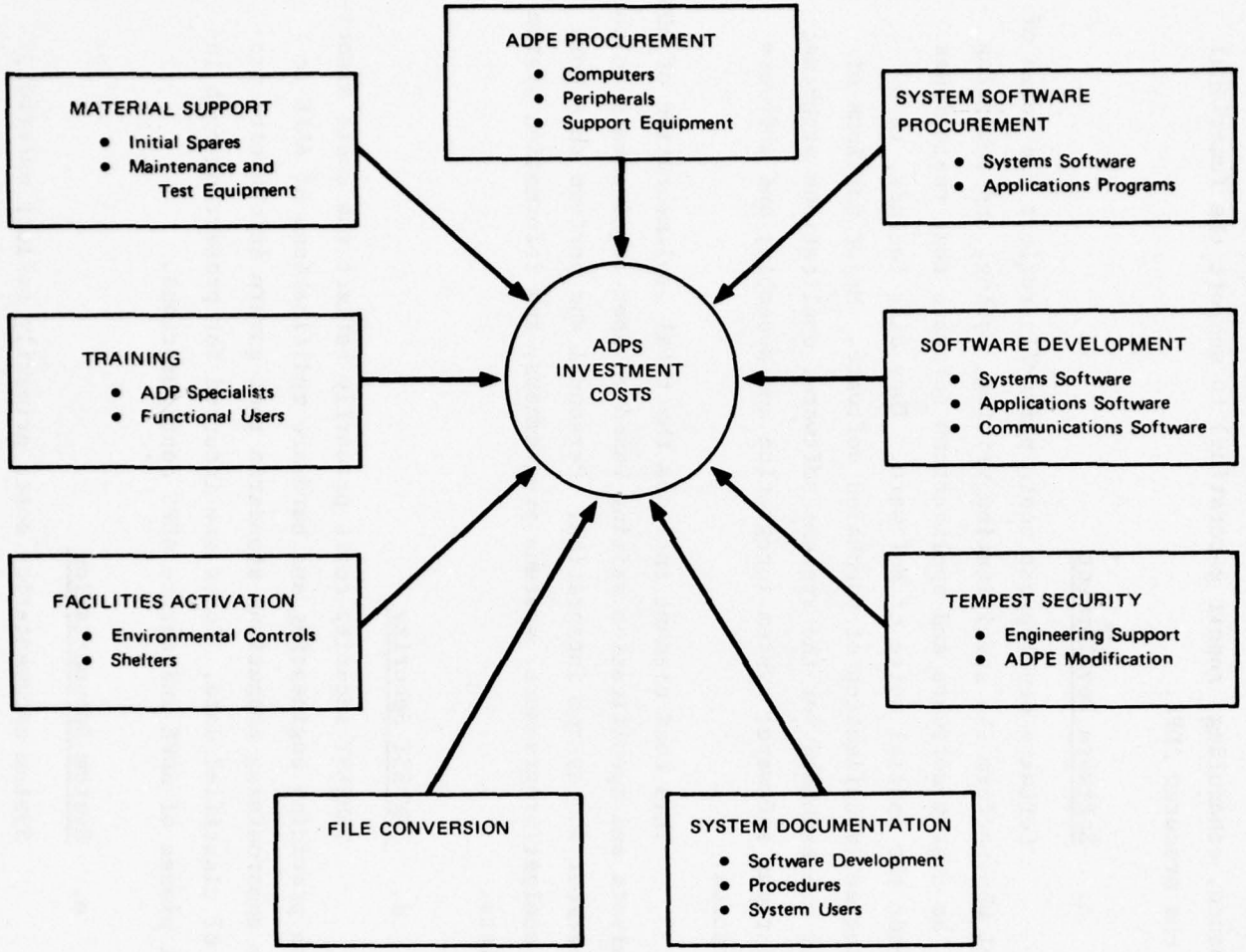


FIGURE 2 ADPS INVESTMENT COST ELEMENTS

this cost are expended for systems software support (operating systems, data base management systems, compilers, and system utilities) of procured ADPE, and for an initial set of applications programs (inventorying, finance, scheduling, report generating) to support the functional uses of the procured ADPE.

c. Software Development

Software development costs primarily reflect the costs of personnel who perform the specification writing, coding, and debugging of both the system software and applications software that replenishes and extends the initial suite of software. They also include, to a lesser degree, modification of purchased software. Major portions of this cost are expended for the systems software; applications programs; communications software; system integration and assembly; and software documentation.

This cost element includes the total implementation of ADS from analysis and specification writing based on user requirements to the final checkout and system integration. Personnel who perform this work include analyst/programmers, systems programmers, and information system specialists.

d. TEMPEST Security

TEMPEST security costs primarily reflect the costs associated with providing engineering and hardware modifications of ADPE to meet the compromising emanations standards that govern information processing of classified data. Costs are incurred for protecting both individual pieces of ADPE and entire ADPS configurations.

e. System Documentation

System documentation costs primarily reflect materiel, supply, and distribution costs associated with the future development of ADPE operations concepts, software concepts and user procedure concepts

for the operational ADPS configuration. Major portions of this cost are expended for updating, revising, and/or creating ADS documentation; maintenance reference manuals; user manuals; and procedures documentation.

f. File Conversion

File conversion costs primarily reflect the personnel costs associated with converting existing data files to the form and format required by the program implementations on the replacement ADPS.

g. Facilities Activation

Facilities activation costs primarily reflect the materiel and labor costs associated with upgrading or building facilities for housing components of the ADPS configuration. Major portions of this cost are expended for labor involved in building shelving, work areas, storage areas, and supplying adequate power and environmental controls, and for materiel that includes transportable shelters, environmental equipments, and building materials.

h. Training

Training costs are primarily personnel costs associated with providing special instruction for the operations and maintenance of ADP resources in general, as well as for the support of specific ADPS configurations. Major portions of this cost are expended for instructors' costs and course management costs (training plans, instruction manuals, class lectures, hands-on user experience with ADPE).

This cost element includes both the training required for ADP professionals (analyst/programmers, systems programmers, operators, and maintenance personnel) and for ADP users (primarily non-ADP oriented managers and data collectors). Personnel who perform this work include computer science professionals and ADPE systems specialists.

i. Materiel Support

Materiel support costs primarily reflect the costs of the initial purchases of spares and repair parts, special test equipment, and special maintenance equipment.

3. Operating Cost Elements

Operating costs are recurring costs associated with the continuous operations, maintenance, management, training, and communications activities that are present from the time the system is introduced in the field to its final phaseout. Costs are incurred and accounted for on an annual basis. Operating cost elements are shown in Figure 3 and described in the following paragraphs.

a. System Management and Operations

System management and operations costs primarily reflect the costs of USMC personnel of appropriate training for the supervision and daily operations associated with the entire ADPS configuration. Personnel who perform this work include analyst/programmers, systems programmers, and ADPE operators.

b. ADPE Maintenance

ADPE maintenance costs primarily reflect the personnel costs associated with the daily upkeep and repair services provided to the ADPE. Major components of this cost element are for USMC ADPE maintenance personnel and for contracted maintenance support from the ADPE supplier.

c. Software Maintenance

Software maintenance costs primarily reflect the personnel costs associated with the updating, modification, or conversion of existing systems software or applications software that follows the initial

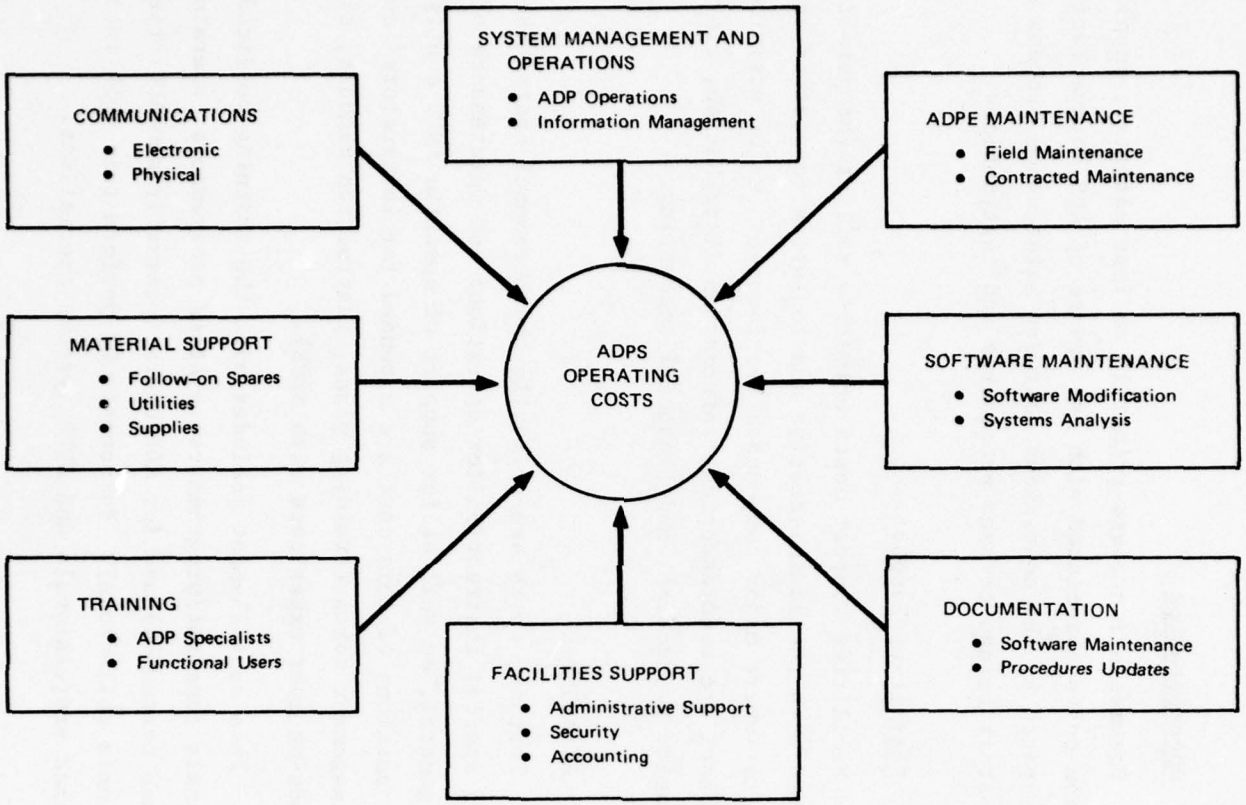


FIGURE 3 ADPS OPERATING COST ELEMENTS

implementation of that software. Major portions of this cost element are expended for systems analysis, programming, and documentation. Personnel who perform this work include analyst/programmers and systems programmers.

d. Documentation

Documentation costs primarily reflect material, supplies, and distribution costs associated with the update of ADS documentation that is necessitated by the continuous software maintenance process and the changes that it brings to user procedures and instructions.

e. Facilities Support

Facilities support costs primarily reflect the personnel costs associated with the administrative and logistics support of the ADPS at the sites where major components are located. Major activities of these personnel are recordkeeping, information distribution, clerical activity, security protection, and financial accounting.

f. Training

Training costs are primarily the personnel costs associated with providing special instruction for operations and maintenance of ADP resources in general, as well as for support of specific ADPS configurations. Major portions of this cost are expended for instructors' costs and course management costs (training plans, instruction manuals, class lectures, hands-on user experience with ADPE).

This cost element includes both the training required for ADP professionals (analyst/programmers, systems programmers, operators, and maintenance personnel) and for ADP users (primarily non-ADP oriented managers and data collectors). Personnel who perform this work include computer science professionals and ADPE systems specialists.

g. Materiel Support

Materiel support costs primarily reflect the costs of supplies, consummables, and special services associated with the daily

operations and maintenance of the ADPE and the exercise of the ADS. Major components of this cost are for ADPE spare parts and repair parts, ADP supplies and rentals (computer paper, tapes, disks), utilities (light, air conditioning, heat), special test equipment, and special test equipment.

h. Communications

Communications costs primarily reflect the costs associated with the lease of telecommunication lines, the purchase of electronic communications equipments other than those integral to the ADPS itself, and the costs of physical transportation of information pertinent to the ADPS (either through the mail or by courier service).

B. Computer Cost Model

The result of SRI's economic analysis of the alternative ADPS concepts is contained in a life cycle cost model that was developed and exercised during this study.

The cost element structure that SRI adopted has been incorporated in the output of a computer cost model as shown in Table 1. Entries along the left hand column define the categories of cost to be addressed. Main headings are Total Development Cost, Total Investment Cost, and Total Operating Cost. Subheadings define subordinate costs within these categories.

Column entries, as shown in Table 1, are categorized by any component system that may be contained within the various alternative ADPS concepts. This level of fidelity has been chosen because of the uncertainty associated with predicting individual equipment and support costs for 1980 systems. The component system cost is further divided into equipment and manpower cost estimates since these areas are of great interest when comparing the costs of alternatives.

The burden of the LCC of a 1980 ADPS depends not only on the total cost and its division according to equipment or human resources, but also on the schedule of expenditures. The LCC is a mixture of recurring and

Table 1

LIFE CYCLE COST MODEL OUTPUT STRUCTURE

	COMPONENT SYSTEM A			COMPONENT SYSTEM B			COMPONENT SYSTEM C			TOTAL
	EQPMNT	MANPWR	TOTAL	EQPMNT	MANPWR	TOTAL	EQPMNT	MANPWR	TOTAL	COST
LIFE CYCLE COST	-	-	-	-	-	-	-	-	-	-
TTL DEVELPMNT COST	-	-	-	-	-	-	-	-	-	-
SYS RESEARCH	-	-	-	-	-	-	-	-	-	-
ENG DEVELPMNT	-	-	-	-	-	-	-	-	-	-
PROTOTYPE SYS	-	-	-	-	-	-	-	-	-	-
SFTWARE DEV	-	-	-	-	-	-	-	-	-	-
SYS DOCUMNTATION	-	-	-	-	-	-	-	-	-	-
SYS TEST+EVAL	-	-	-	-	-	-	-	-	-	-
TRAINING	-	-	-	-	-	-	-	-	-	-
MATERIEL SUP	-	-	-	-	-	-	-	-	-	-
TTL INVESTMNT COST	-	-	-	-	-	-	-	-	-	-
ADPE PROC	-	-	-	-	-	-	-	-	-	-
SYS SFTWARE PROC	-	-	-	-	-	-	-	-	-	-
SFTWARE DEV	-	-	-	-	-	-	-	-	-	-
TEMPEST SECURITY	-	-	-	-	-	-	-	-	-	-
SYS DOCUMNTATION	-	-	-	-	-	-	-	-	-	-
FILE CONVERSION	-	-	-	-	-	-	-	-	-	-
FACILITIES ACTIV	-	-	-	-	-	-	-	-	-	-
TRAINING	-	-	-	-	-	-	-	-	-	-
MATERIEL SUP	-	-	-	-	-	-	-	-	-	-
TTL OPERATING COST	-	-	-	-	-	-	-	-	-	-
SYS MGT+OPS	-	-	-	-	-	-	-	-	-	-
ADPE MAINT	-	-	-	-	-	-	-	-	-	-
SFTWARE MAINT	-	-	-	-	-	-	-	-	-	-
DOCUMENTATION	-	-	-	-	-	-	-	-	-	-
FACILITIES SUP	-	-	-	-	-	-	-	-	-	-
TRAINING	-	-	-	-	-	-	-	-	-	-
MATERIEL SUP	-	-	-	-	-	-	-	-	-	-
COMMUNICATIONS	-	-	-	-	-	-	-	-	-	-

nonrecurring expenditures for development, investment, and operations. These occur at various stages of the life of the systems. For this reason the SRI cost analysis model also summarizes the yearly expenditure of resources to identify the schedule burden of a particular alternative concept. That time-phased breakout is shown in Table 2. The component system entries of Table 1 have been aggregated in Table 2 according to the cost element categorization and distributed over the years that they are expected to occur.

It should be noted that in both tables, the entries are made in terms of constant 1977 dollars. Discounting schemes do not appear justified at this stage of concept formulation because of the various uncertainties associated with the alternative ADPS concepts that have been described.

C. Cost Estimating Approach

Cost estimating during the concept formulation phase of the acquisition process is inherently less precise than it is during succeeding phases. The primary reasons for this are the lack of system definition that is possible at this stage, and the fact that costs must be estimated up to 15 years in the future. What data is available comes from a variety of sources based on various experience factors, as well as some quantitative numbers. There is no single source of consistent and complete data. For this reason the cost estimates contained in Sections II, III, and IV should be taken as initial approximations that must be refined continually as more precise data becomes available.

SRI used several major sources of cost data during the course of the data collection effort. The sources are:

- Basic manpower billet costs.[4]
- Basic cost data and budgetary requests reported for the existing Marine Corps ADPS.[5]
- Cost data from ongoing ADPS development programs.[6-11]
- Cost analyses conducted for other Services' ADPS studies.[12-16]
- Cost experience from the commercial sector.
- Direct manufacturer ADPS cost quotations.[17]

Table 2

LIFE CYCLE COST MODEL SCHEDULE

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
LIFE CYCLE COST	-	-	-	-	-	-	-	-	-	-
TTL DEVELPMNT COST	-	-	-	-	-	-	-	-	-	-
SYS RESEARCH	-	-	-	-	-	-	-	-	-	-
ENG DEVELPMNT	-	-	-	-	-	-	-	-	-	-
PROTOTYPE SYS	-	-	-	-	-	-	-	-	-	-
SFTWARE DEV	-	-	-	-	-	-	-	-	-	-
SYS DOCUMNTATION	-	-	-	-	-	-	-	-	-	-
SYS TEST+EVAL	-	-	-	-	-	-	-	-	-	-
TRAINING	-	-	-	-	-	-	-	-	-	-
MATERIEL SUP	-	-	-	-	-	-	-	-	-	-
TTL INVESTMNT COST	-	-	-	-	-	-	-	-	-	-
ADPE PROC	-	-	-	-	-	-	-	-	-	-
SYS SFTWARE PROC	-	-	-	-	-	-	-	-	-	-
SFTWARE DEV	-	-	-	-	-	-	-	-	-	-
TEMPEST SECURITY	-	-	-	-	-	-	-	-	-	-
SYS DOCUMNTATION	-	-	-	-	-	-	-	-	-	-
FILE CONVERSION	-	-	-	-	-	-	-	-	-	-
FACILITIES ACTIV	-	-	-	-	-	-	-	-	-	-
TRAINING	-	-	-	-	-	-	-	-	-	-
MATERIEL SUP	-	-	-	-	-	-	-	-	-	-
TTL OPERATING COST	-	-	-	-	-	-	-	-	-	-
SYS MGT+OPS	-	-	-	-	-	-	-	-	-	-
ADPE MAINT	-	-	-	-	-	-	-	-	-	-
SFTWARE MAINT	-	-	-	-	-	-	-	-	-	-
DOCUMENTATION	-	-	-	-	-	-	-	-	-	-
FACILITIES SUP	-	-	-	-	-	-	-	-	-	-
TRAINING	-	-	-	-	-	-	-	-	-	-
MATERIEL SUP	-	-	-	-	-	-	-	-	-	-
COMMUNICATIONS	-	-	-	-	-	-	-	-	-	-

Table 2 (Concluded)

	1988	1989	1990	1991	TOTAL LCC
LIFE CYCLE COST	-	-	-	-	-
TTL DEVELPMNT COST	-	-	-	-	-
SYS RESEARCH	-	-	-	-	-
ENG DEVELPMNT	-	-	-	-	-
PROTOTYPE SYS	-	-	-	-	-
SFTWARE DEV	-	-	-	-	-
SYS DOCUMNTATICN	-	-	-	-	-
SYS TEST+EVAL	-	-	-	-	-
TRAINING	-	-	-	-	-
MATERIEL SUP	-	-	-	-	-
TTL INVESTMNT COST	-	-	-	-	-
ADPE PROC	-	-	-	-	-
SYS SFTWARE PRCC	-	-	-	-	-
SFTWARE DEV	-	-	-	-	-
TEMPEST SECURITY	-	-	-	-	-
SYS DOCUMNTATICN	-	-	-	-	-
FILE CONVERSION	-	-	-	-	-
FACILITIES ACTIV	-	-	-	-	-
TRAINING	-	-	-	-	-
MATERIEL SUP	-	-	-	-	-
TTL OPERATING COST	-	-	-	-	-
SYS MGT+OPS	-	-	-	-	-
ADPE MAINT	-	-	-	-	-
SFTWARE MAINT	-	-	-	-	-
DOCUMENTATION	-	-	-	-	-
FACILITIES SUP	-	-	-	-	-
TRAINING	-	-	-	-	-
MATERIEL SUP	-	-	-	-	-
COMMUNICATIONS	-	-	-	-	-

Each of these sources satisfied aspects of the total cost picture that was desired. Some aspects were in different forms, however, and SRI correlated and assembled the pertinent portions of each into quantitative cost figures as accurately as possible.

For the baseline ADS concept, cost data was obtained from inventory listings, budgetary requests, and cost breakdowns of expenditures for existing ADS systems elicited from HQMC monitoring agencies.[5] These sources were particularly valuable for determining current manpower allocations, operational costs, and recurring equipment costs. Table of Organization sources also provided information on current FMF ADP billets.

Extensive use was made of data collected by ongoing ADS development programs such as the Navy's Naval Aviation Logistics Command Management Information System (NALCOMIS), the Air Force's SADPR-85 study, as well as the Marine Corp's MTACCS development. These sources provided data on systems conversions, software development, facility support, training, material support, and communications. Some of this material was directly usable dollar estimates. Because complete life cycle costing was performed in these development programs, representative cost estimating relationships were established that provided internal consistency to SRI's LCC estimates.

The commercial ADP sector provided indicators of how the ADP industry views the cost trends for future ADPS configurations. Commercial experience also deepened the reservoir of knowledge for producing cost estimating relationships inherent in all ADPS, especially those based on the newer minicomputer and microcomputer technologies.

Finally, direct manufacturer equipment quotations provided guidelines and ballpark estimates, especially of the major ADPE costs. This source also provided data concerning system support equipment options, spare parts, and maintenance requirements.

Much of the detailed data from these sources was aggregated to obtain an appropriate level of cost information for the concepts SRI generated. This aggregation included the development of numerous cost estimating extrapolations, engineering estimates, and rules of thumb. All assumptions of this type are well documented in the following sections.

II BASELINE LIFE CYCLE COSTS

The cost estimates presented in this section are for the BASELINE ADPS concept that is described in detail in Volume IV of this study report. To provide a point of reference, Section II begins with a brief overview of the BASELINE concept. Following that, each of the cost elements that occur as components of the development, investment, or operating costs of the ADPS LCC are addressed, and assumptions and sources of data are identified that influenced the calculation of the separate elements.

A. Concept Overview

1. System Logic

BASELINE provides centralized computing power to the FMF at the higher command levels. Each MAF is provided two large general purpose computing systems; these are used to provide a range of centralized ADP support primarily to the division/wing/FSSG echelon, and secondarily (through the division/wing/FSSG echelon) to the lower echelons. Each such facility at the MAF level serves the local user community that is located within its geographic area of responsibility. Additionally, the air groups within each wing have an organic data processing capability provided by a smaller general-purpose computing system. This system is dedicated to support of Naval aviation supply and maintenance systems. General purpose computing systems also reside at FMF headquarters level.

The physical size and the burdensome support requirements of the BASELINE computers severely limit their mobility. Deployed MAGTF's cannot be supported afloat by the MAF computers, and deployment of these systems to an objective area requires from 60 to 120 days. All BASELINE computers require closely environmental conditions characteristic of the second and early third generation equipment that they represent.

BASELINE is a rigid and narrowly focussed system. It supports the division/wing/FSSG echelon well in garrison, but it has little flexibility to accommodate the afloat or deployed ashore environments, and it does not support MABs, MAUs, or lower echelon units responsively, if at all.

BASELINE is designed to support the flow of administrative information (manpower, operations, logistics, financial) from the FMF to higher headquarters. This is accomplished by transcribing the manual data input from the lower echelons to computer cards or OCR media, organizing the data, and either locally processing the data for MAF level use or passing the cards and OCR media on to the Supporting Establishment. Generalized reports on a strictly scheduled basis flow back to the lower echelons from the MAF-level computers.

Force automated service centers (FASCs) provide deployable, generalized data processing capability to the three MAFs. There are six such FACs (two per MAF), and they are resident with elements of the MAF in garrison. Each MAF possesses an IBM 360/65 system and an IBM 360/50 system. These systems are intended primarily to support (subject to the need for garrison efficiency) ground combat elements and combat service support elements.

Within each MAG is contained a computer system that provides a deployable, Navy supply dedicated data processing capability to support the air combat element. BASELINE includes seventeen U-1500 (AN/UYK-5) computer systems for this purpose.

Aboard LCC- and LHA-class ships, the USMC Commander Landing Force (CLF) has access to a computer system on which he may exercise the ASIS shipboard command and control system. Aboard the LCCs, the computer system is the second generation UNIVAC CP-642B; aboard the LHAs the computer system is the third generation UNIVAC AN/UYK-7.

BASELINE to a large extent is computer card and paper oriented. The flow of information is primarily through the physical transportation of paper. AUTODIN is used for some high level electronic communication, but no provision has been made to use LFICS.

BASELINE provides a manual/automated system for reporting Class I ADS information to the upper FMF echelons and Supporting Establishment, but there are no effective resources for providing functional capabilities to meet the local units' command and management information processing requirements. Figure 4 outlines the ADP system and organizational relationships for BASELINE in a deployed MAGTF.

2. System Implementation

BASELINE's structure provides for a single, centralized, large computer system to be located at the MAF command level. This is an IBM 360/65, and it is the principal ADPE for the FASC. This computer system operates under a service type of concept that serves the three combat elements (air, ground, CSS) of the FMF. Functionally, it sits at the top of a manual/semi-automated information reporting system, so that it is the focus for the FMF's automated interaction with the Supporting Establishment.

BASELINE also includes a UNIVAC 1500 computing system located with each Marine Air Group. This system is dedicated to Navy aviation supply, so that the concept of its usage is much narrower than that of the FASC.

A summary of the component systems contained in BASELINE is contained in Table 3, along with an overview of the system functions that they provide.

B. Cost Estimate Review

The total LCC estimated for the BASELINE concept is summarized in the computer output of the SRI LCC model in Tables 4 and 5. As shown in the summary totals of those tables, BASELINE is projected to cost $300,407,200. The cost is to be incurred over a 10-year operational lifetime.

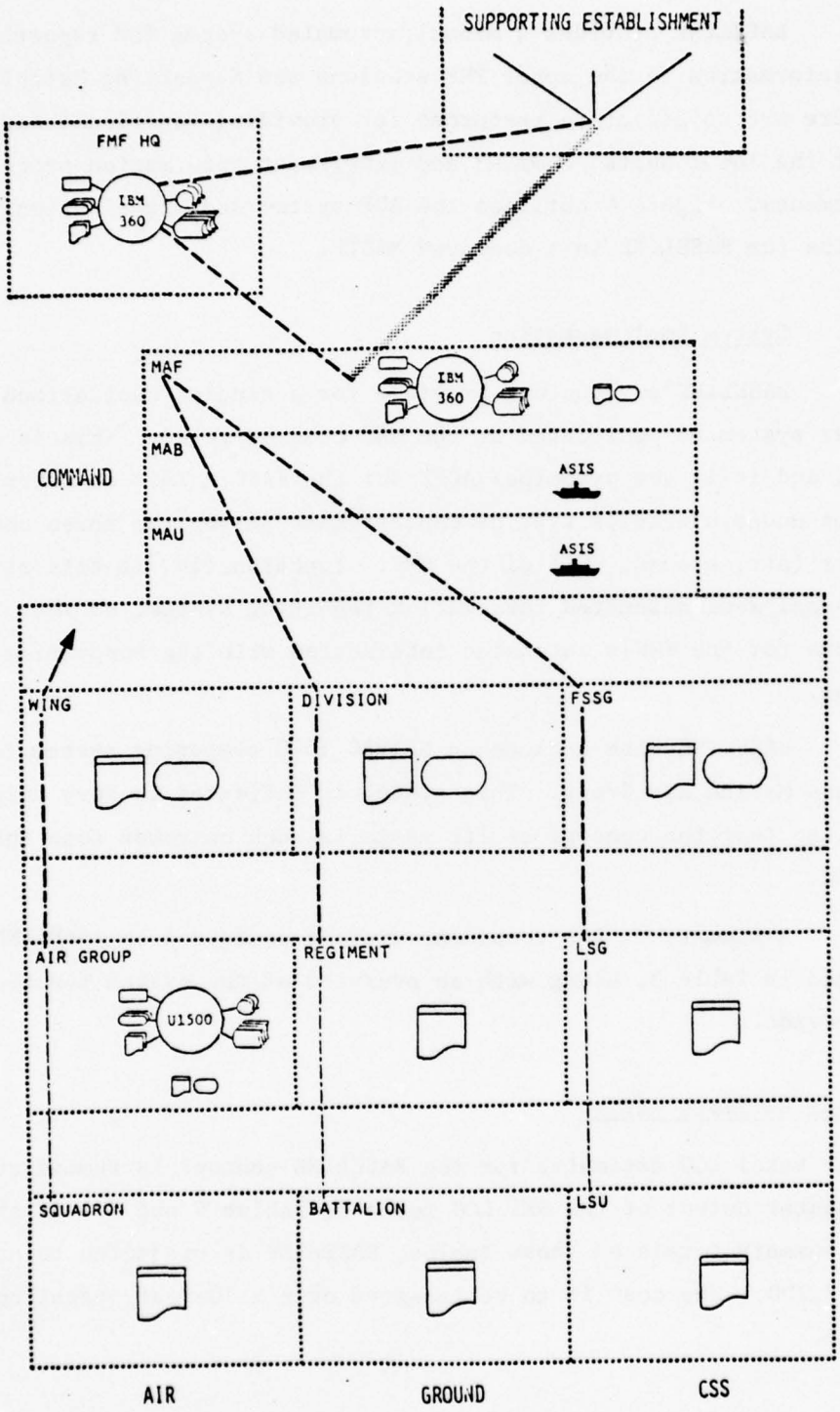


FIGURE 4 BASELINE OVERVIEW

Table 3

BASELINE ADPS IMPLEMENTATION

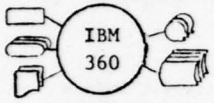
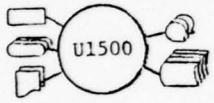
Component Systems	Hardware Characteristics	System Software Features	Supported System Functions
 IBM System 360	Large scale 3rd generation general purpose computer system Extensive disk auxiliary memory Extensive tape auxiliary memory One or more high speed hard copy printers Punch-card *I/O devices* Interactive keyboard terminals Telecommunications interface	Multiprogramming operating system Utility program library Low level language processor (assembler) Higher level language compiler and programming aids File management and *retrieval package* Text handling package	Data entry Data handling Report generation Data retrieval File creation for data forwarding
 UNIVAC 1500	Medium scale, 2nd-3rd generation, partially militarized general purpose computer system One magnetic tape unit One high-speed hardcopy printer *One teletypewriter* One punch-card reader/punch	Executive program Assembler program Language compiler Loader Utility package	Data entry Data handling Report generation File creation for data forwarding

Table 4

BASELINE LIFE CYCLE COST SUMMARY
(Dollars in Thousands)

	FASC IBM 360			MAG U-1500			FMF HQS IBM 360			TOTAL
	EQPMNT	MANPWR	TOTAL	EQPMNT	MANPWR	TOTAL	EQPMNT	MANPWR	TOTAL	COST
LIFE CYCLE COST	22812.0	170332.0	193144.0	-	63187.7	63187.7	4083.3	39992.2	44075.5	300407.2
TTL DEVELPMNT COST	-	-	-	-	-	-	-	-	-	-
SYS RESEARCH	-	-	-	-	-	-	-	-	-	-
ENG DEVELPMNT	-	-	-	-	-	-	-	-	-	-
PROTOTYPE SYS	-	-	-	-	-	-	-	-	-	-
SFTWARE DEV	-	-	-	-	-	-	-	-	-	-
SYS DOCUMNTATION	-	-	-	-	-	-	-	-	-	-
SYS TEST+EVAL	-	-	-	-	-	-	-	-	-	-
TRAINING	-	-	-	-	-	-	-	-	-	-
MATERIEL SUP	-	-	-	-	-	-	-	-	-	-
TTL INVESTMNT COST	-	-	-	-	-	-	-	-	-	-
ADPE PROC	-	-	-	-	-	-	-	-	-	-
SYS SFTWARE PROC	-	-	-	-	-	-	-	-	-	-
SFTWARE DEV	-	-	-	-	-	-	-	-	-	-
TEMPEST SECURITY	-	-	-	-	-	-	-	-	-	-
SYS DOCUMNTATION	-	-	-	-	-	-	-	-	-	-
FILE CONVERSION	-	-	-	-	-	-	-	-	-	-
FACILITIES ACTIV	-	-	-	-	-	-	-	-	-	-
TRAINING	-	-	-	-	-	-	-	-	-	-
MATERIEL SUP	-	-	-	-	-	-	-	-	-	-
TTL OPERATING COST	22812.0	170332.0	193144.0	-	63187.7	63187.7	4083.3	39992.2	44075.5	300407.2
SYS MGT+OPS	0.0	137418.7	137418.7	0.0	50977.9	50977.9	0.0	33246.4	33246.4	221643.0
ADPE MAINT	0.0	4557.0	4557.0	0.0	1690.5	1690.5	0.0	1102.5	1102.5	7350.0
SFTWARE MAINT	-	-	-	-	-	-	-	-	-	-
DOCUMENTATION	-	-	-	-	-	-	-	-	-	-
FACILITIES SUP	0.0	23325.6	23325.6	0.0	8653.1	8653.1	0.0	5643.3	5643.3	37622.0
TRAINING	0.0	5030.7	5030.7	0.0	1866.2	1866.2	1217.1	0.0	1217.1	8114.0
MATERIEL SUP	22812.0	0.0	22812.0	-	-	-	2866.2	0.0	2866.2	25678.2
COMMUNICATIONS	-	-	-	-	-	-	-	-	-	-

Table 5

BASELINE LIFE CYCLE COST SCHEDULE
(Dollars in Thousands)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
LIFE CYCLE COST	-	-	-	-	30040.8	30040.8	30040.7	30040.7	30040.7	30040.7
TTL DEVELPMNT COST	-	-	-	-	-	-	-	-	-	-
SYS RESEARCH	-	-	-	-	-	-	-	-	-	-
ENG DEVELPMNT	-	-	-	-	-	-	-	-	-	-
PROTOTYPE SYS	-	-	-	-	-	-	-	-	-	-
SFTWARE DEV	-	-	-	-	-	-	-	-	-	-
SYS DOCUMNTATION	-	-	-	-	-	-	-	-	-	-
SYS TEST+EVAL	-	-	-	-	-	-	-	-	-	-
TRAINING	-	-	-	-	-	-	-	-	-	-
MATERIEL SUP	-	-	-	-	-	-	-	-	-	-
TTL INVESTMNT COST	-	-	-	-	-	-	-	-	-	-
ADPE PROC	-	-	-	-	-	-	-	-	-	-
SYS SFTWARE PROC	-	-	-	-	-	-	-	-	-	-
SFTWARE DEV	-	-	-	-	-	-	-	-	-	-
TEMPEST SECURITY	-	-	-	-	-	-	-	-	-	-
SYS DOCUMNTATION	-	-	-	-	-	-	-	-	-	-
FILE CONVERSION	-	-	-	-	-	-	-	-	-	-
FACILITIES ACTIV	-	-	-	-	-	-	-	-	-	-
TRAINING	-	-	-	-	-	-	-	-	-	-
MATERIEL SUP	-	-	-	-	-	-	-	-	-	-
TTL OPERATING COST	-	-	-	-	30040.8	30040.8	30040.7	30040.7	30040.7	30040.7
SYS MGT+OPS	-	-	-	-	22164.3	22164.3	22164.3	22164.3	22164.3	22164.3
ADPE MAINT	-	-	-	-	735.0	735.0	735.0	735.0	735.0	735.0
SFTWARE MAINT	-	-	-	-	-	-	-	-	-	-
DOCUMENTATION	-	-	-	-	-	-	-	-	-	-
FACILITIES SUP	-	-	-	-	3762.2	3762.2	3762.2	3762.2	3762.2	3762.2
TRAINING	-	-	-	-	811.4	811.4	811.4	811.4	811.4	811.4
MATERIEL SUP	-	-	-	-	2567.9	2567.9	2567.8	2567.8	2567.8	2567.8
COMMUNICATIONS	-	-	-	-	-	-	-	-	-	-

Table 5 (Concluded)

	1988	1989	1990	1991	TOTAL LCC
LIFE CYCLE COST	30040.7	30040.7	30040.7	30040.7	300407.2
TTL DEVELPMNT COST	-	-	-	-	-
SYS RESEARCH	-	-	-	-	-
ENG DEVELPMNT	-	-	-	-	-
PROTOTYPE SYS	-	-	-	-	-
SFTWARE DEV	-	-	-	-	-
SYS DOCUMNTATION	-	-	-	-	-
SYS TEST+EVAL	-	-	-	-	-
TRAINING	-	-	-	-	-
MATERIEL SUP	-	-	-	-	-
TTL INVESTMNT COST	-	-	-	-	-
ADPE PROC	-	-	-	-	-
SYS SFTWARE PROC	-	-	-	-	-
SFTWARE DEV	-	-	-	-	-
TEMPEST SECURITY	-	-	-	-	-
SYS DOCUMNTATION	-	-	-	-	-
FILE CONVERSION	-	-	-	-	-
FACILITIES ACTIV	-	-	-	-	-
TRAINING	-	-	-	-	-
MATERIEL SUP	-	-	-	-	-
TTL OPERATING COST	30040.7	30040.7	30040.7	30040.7	300407.2
SYS MGT+OPS	22164.3	22164.3	22164.3	22164.3	221643.0
ADPE MAINT	735.0	735.0	735.0	735.0	7350.0
SFTWARE MAINT	-	-	-	-	-
DOCUMENTATION	-	-	-	-	-
FACILITIES SUP	3762.2	3762.2	3762.2	3762.2	37622.0
TRAINING	811.4	811.4	811.4	811.4	8114.0
MATERIEL SUP	2567.8	2567.8	2567.8	2567.8	25678.2
COMMUNICATIONS	-	-	-	-	-

1. BASELINE Development Cost

As shown in Table 4, no development cost has been projected for BASELINE. BASELINE is a mature system according to the viewpoint that has been adopted for this study, and it will not require any significant expenditure of resources for future development as a system configuration.

2. BASELINE Investment Cost

As shown in Table 4, no investment cost has projected for BASELINE. BASELINE is a mature system according to the viewpoint that has been adopted for this study, and it will not require any significant expenditure of resources for future investment as a system configuration.

3. BASELINE Operating Cost

As shown in Table 4, the projected operating cost for BASELINE is $300,407,200. This projection is based on analysis of typical BASELINE experience and budgetary estimates, with the following assumptions:

- The operational lifetime of the system will be 10 years beginning in 1982 (to be compatible with the IOC of the alternative ADPS for comparative purposes).
- Operating costs will be incurred continuously during the operational lifetime according to a schedule of 10% per year for 10 years.

The component cost elements of the total operating cost are addressed in the paragraphs below.

a. System Management and Operations

The projected system management and operations cost is estimated to be $221,643,000, or approximately 74% of the total operating cost.

System management and operations cost was estimated to be the product of the number of current FMF ADP operations billets, and their billet costs as shown in Table 6. Billet costs were taken from Reference 4 and adjusted to make that data current to 1977. Billet costs contain

Table 6

FMF ADP BILLET COSTS

Military Grade	Annual Billet Cost
O-6	$86,000
O-5	64,000
O-4	52,900
O-3	43,900
O-2	38,400
O-1	30,200
W-4	52,000
W-3	43,000
W-2	36,000
W-1	32,000
E-9	44,900
E-8	36,340
E-7	32,100
E-6	31,800
E-5	26,000
E-4	20,700
E-3	20,300
E-2/1	16,400

all salary and burden costs that can be ascribed to the LCC of each Marine of a particular rank and occupational specialty. The number of current FMF ADP operations billets was determined from FMF summary tables contained in the Marine Corps Tables of Organization. This was estimated to be 827 billets.

b. ADPE Maintenance Cost

The projected ADPE maintenance cost is estimated to be $7,350,000, or approximately 2% of the total operating cost.

The ADPE maintenance cost was estimated as the product of the number of current FMF ADPE maintenance billets, and their billet costs as shown in Table 6. Billet costs contain all salary and burden costs that can be ascribed to the LCC of each Marine of a particular rank and occupational specialty. The number of current FMF ADP maintenance billets was determined from FMF summary tables contained in the Marine Corps Tables of Organization. This was estimated to be 35 billets.

c. Software Maintenance Cost

No estimate of the software maintenance cost for BASELINE was made since the greatest portion of software maintenance is performed in the CDPA's of the Supporting Establishment. There appeared to be no easy method for ascertaining the total CDPA cost or the portion that should be applied to maintenance, therefore, no estimate was projected.

d. Documentation Cost

No estimate of the software maintenance cost for BASELINE was made for the same reasons cited for the software maintenance cost element.

e. Facilities Support Cost

The projected facilities support cost is estimated to be $37,622,000, or approximately 13% of the total operating cost.

Facilities support cost was estimated on the basis of ratios of a similar cost category contained in the LCC estimates of Reference 13. Specifically, facilities support cost was calculated to be 15% of the combined costs of the software development, system management and operations, ADPE maintenance, and software maintenance cost elements.

f. Training Cost

The projected training cost is estimated to be $8,114,000, or approximately 3% of the total operating cost.

Training cost was estimated by taking the number of personnel who would need to be trained in operations and maintenance of the BASELINE ADPS per year, and multiplying that number by the cost to train each individual. Since salary, burden, and basic background training (such as basic electronics course) is included in the man-year billet costs that SRI associated with each system, only the cost of organizing and delivering specialized courses is included in the training cost. References 7, 11, and 13, as well as direct quotations from ADPE manufacturers indicated that the cost of a week of such training is approximately $700. SRI estimated that a representative period of 4 weeks of training would be an appropriate projection across all skill categories; therefore, SRI accounted a cost of $2800 per individual trained.

BASELINE is a mature system, so the actual number of personnel who need to be trained each year include only those people entering the ADP field, or those people assuming new jobs for which they have not been trained. SRI estimated that this number was 30% of the total operations and maintenance staff of 862 per year.

g. Materiel Support Cost

The projected materiel support cost is estimated to be $25,678,200, or approximately 9% of the total operating cost.

Materiel support cost was estimated by extrapolation of the appropriate categories of equipment and supplies that have been reported as budgetary requirements for the next 5 years as part of the Navy Department's ADP monitoring function described in Reference 5. It should be noted in Table 4 that no entry was made for the MAG U-1500 system. This was because the U-1500 is supported by Navy resources.[18]

h. Communications Cost

No estimate of the communications cost for BASELINE was made because electronic communications is not stressed by the BASELINE concept, and because there appears to be no representative source of information on which to base an estimate of non-electronic communications costs.

4. Cost Perspectives

As a means of summarizing, interpreting, and ascertaining the importance of various elements and components of the BASELINE LCC, two additional pieces of information are presented in Table 7 and Figure 5. Table 7 addresses the relative impact on the BASELINE LCC of the three LCC phases, the three component systems, and the manpower and equipment resources. Figure 5 graphically represents the profile of annual expenditures required to develop, operate, and maintain the BASELINE concept over its life cycle.

Table 7

BASELINE COST ELEMENT PERSPECTIVES

Cost Element	Percent of BASELINE LCC
LCC Phases	
• Development	--
• Investment	--
• Operations	100.00
Component Systems	
• FASC IBM 360	64.3
• MAG U-1500	21.0
• FMF HQS IBM 360	14.7
Resources	
• Equipment	9.0
• Manpower	91.0

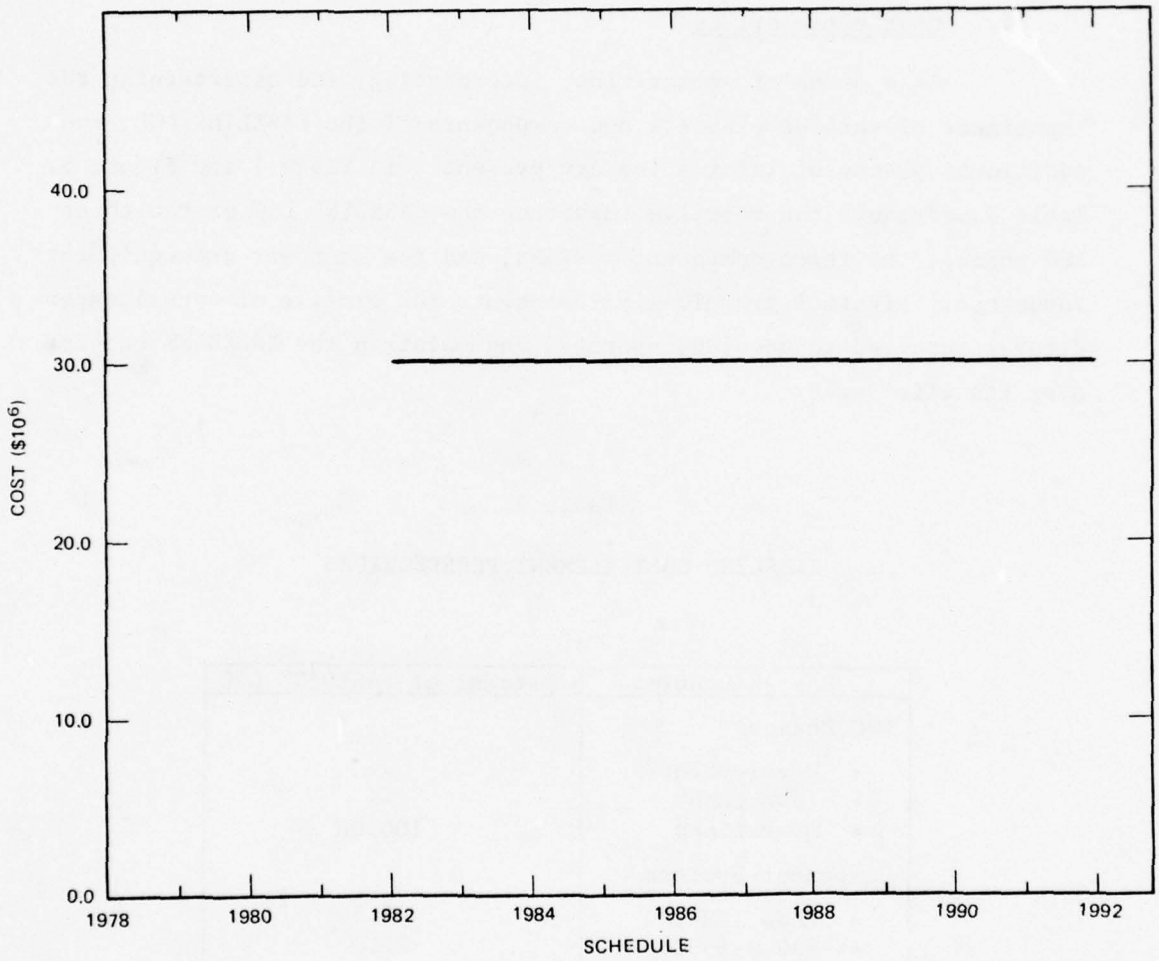


FIGURE 5 ANNUAL BASELINE LCC EXPENDITURES

III DISHIER LIFE CYCLE COSTS

The cost estimates presented in this section are for the Distributed Hierarchical (DISHIER) ADPS concept that is described in detail in Volume IV of this study report. To provide a point of reference, this section begins with a brief overview of the DISHIER concept. Following that, each of the life cycle cost elements that occur as components of the development, investment, or operating costs of the ADPS LCC are addressed, and assumptions and sources of data are identified that influenced the calculation of the separate elements.

A. Concept Overview

1. System Logic

DISHIER provides graduated computing power to the FMF from the highest command level down to the battalion/squadron level. This is accomplished through the assignment of a structure of mutually supporting ADP workload responsibilities--organized similarly for each combat element (air, ground, CSS). At each echelon the workload is supported by a processing resource that ranges from large variable-configuration minicomputer systems at FMFPAC/FMFLANT level through minicomputer-based systems to small stand-alone micro-processor systems at the battalion/squadron echelon.

The physical size and support requirements of the component systems are matched to the support capabilities and mobility requirements of the units they support. Hence, deployed MAGTFs can be supported afloat/ashore using the same ADP equipment and procedures that serve their garrison requirements.

The overall system concept provides modularity through a hierarchy of component systems that differ in size, capacity, and function.

The flexibility of these modular building blocks allows DISHIER to accomodate readily different MAGTF configurations and differing intensities of operations.

DISHIER is designed to support all Class I administrative reporting requirements (manpower, operations, logistics, financial) at each echelon level. This is achieved through an SDA-like capability to capture information in a machine-readable form close to the source. That capability is augmented by editing, validating, summarization, and aggregation capabilities at each echelon, as well as each echelon's ability to transmit the reporting information up and down the organizational chain.

Vertical information flow paths exist between successive echelons in DISHIER. Each of these consists of one or more two-way electronic data transmission links (through LFICS). In the absence of such links, digital data on machine readable media (for example, cassettes or floppy disks) can be physically transported from point to point via any suitable transportation means.

DISHIER further provides functional capabilities to meet the local units' internal command and management information processing requirements. These capabilities (such as local inquiry, retrieval, update, and sort) are tailored to correspond to the nature and the volume of the workload assigned each echelon level. The use of and access to these capabilities are oriented toward actual users of the information (commanders and unit staff members) rather than the data-processing intermediaries.

Serving simultaneously the reporting and local usage requirements, DISHIER is in every sense a generalized management tool. It is a tool that is shared among the functional management areas (manpower, operations and training, logistics, and finance)--serving the particular needs of the unit, rather than those of one functional area. As such, the capability DISHIER provides must be shared among a group of users according to the need and priority to be established at each echelon.

Figure 6 outlines the ADP system and organizational relationship for DISHIER in a deployed MAGTF. One of the distinguishing characteristics

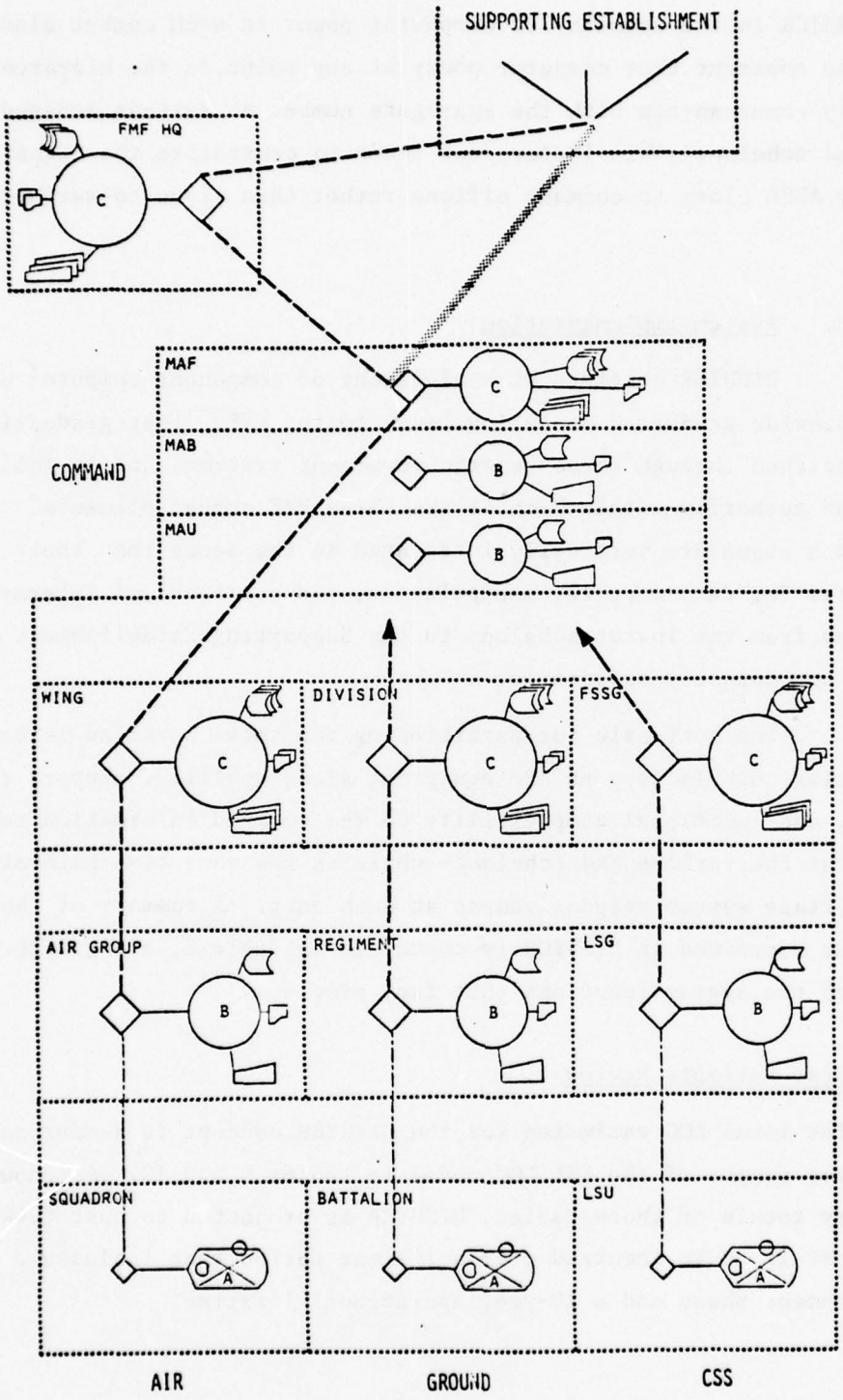


FIGURE 6 DISHIER OVERVIEW

of DISHIER is the symmetry of computing power in each combat element. It is also apparent that computer power at any point in the hierarchy is roughly commensurate with the aggregate number of Marines managed by each command echelon. This latter fact tends to centralize the higher capability ADPE close to command offices rather than close to warehouses or shops.

2. System Implementation

DISHIER consists of a hierarchy of component computer systems that provide graduated computing power to the FMF. That graduation is accomplished through three generic component systems, and it follows the command authority within each of the three FMF combat elements. The component systems are vertically integrated in the sense that their capabilities for data capture, manipulation, and retrieval of information flowing from the lowest echelons to the Supporting Establishment are distinct but mutually supporting.

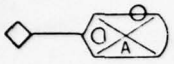
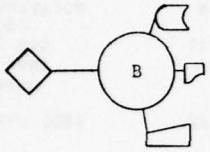
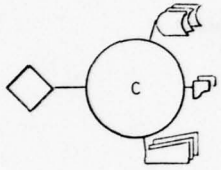
The rationale for partitioning the total workload is based on tailoring such factors as ADP equipment size, mobility, support requirements, and functional compatibility to the command information requirements at the various FMF echelons--while at the same time maintaining an appropriate system responsiveness at each unit. A summary of the component systems contained in DISHIER is contained in Table 8, along with an overview of the system functions that they provide.

B. Cost Estimate Review

The total LCC estimated for the DISHIER concept is summarized in the computer output of the SRI LCC model in Tables 9 and 10. As shown in the summary totals of those tables, DISHIER is projected to cost $244,877,300. The cost is to be incurred over a 14-year period that includes a 4-year development phase and a 10-year operational lifetime.

Table 8

DISHIER ADPS IMPLEMENTATION

Component Systems	Hardware Characteristics	System Software Features*	Supported System Functions
 System A	Micro-processor based system Programmable or PROM processor RAM main storage Auxiliary storage Keyboard/display input device Hardcopy output device Telecommunications interface Removable magnetic I/O medium	Control program System utilities Application language processors System diagnostic routines Preprogrammed applications Text handler	Data capture, verification, and editing Simple word and text processing Simple file management of small files Simple information storage and retrieval Numerical calculation Report formatting System self-diagnosis Data communication
 System B	Mini-processor based system Programmable processor Multiprogramming processor hardware Sizeable main and auxiliary storage Multiple keyboard/display input devices Multiple hardcopy printers Telecommunications interface Removable magnetic I/O medium	Operating system for batch and interactive processing Report generator program Preprogrammed applications Query language Rudimentary programming aids	Foreground/background processing Sophisticated storage and retrieval File management Report generation Data communication
 System C	Mini-processor system--variable configuration Multiprogramming processor hardware Ample main storage Extensive auxiliary storage Multiple keyborad/display input devices Multiple hardcopy printers Telecommunications interface Removable magnetic I/O medium	Multiprogramming operating system Compilers for high-level languages Utility program library Diagnostic program package	Multiprogramming and interactive processing String processing General data base management Interoperability interfaces High speed, high volume data communication

*It is anticipated that many of these features may be implemented in firmware.

Table 9

DISHIER LIFE CYCLE COST SUMMARY
(Dollars in Thousands)

	COMPONENT SYSTEM A			COMPONENT SYSTEM B			COMPONENT SYSTEM C			TOTAL
	EQPMNT	MANPWR	TOTAL	EQPMNT	MANPWR	TOTAL	EQPMNT	MANPWR	TOTAL	COST
LIFE CYCLE COST	27950.8	20626.0	48576.8	18720.1	82177.3	100897.4	20082.2	75320.9	95403.1	244877.3
TTL DEVELPMNT COST	2297.5	4802.8	7100.3	1448.3	3975.0	5423.3	1321.2	4457.4	5778.6	18302.2
SYS RESEARCH	0.0	369.1	369.1	0.0	369.1	369.1	0.0	369.1	369.1	1107.3
ENG DEVELPMNT	0.0	800.0	800.0	0.0	800.0	800.0	0.0	800.0	800.0	2400.0
PROTOTYPE SYS	1310.0	700.0	2010.0	756.0	372.4	1128.4	599.0	957.5	1556.5	4694.9
SFTWARE DEV	0.0	2049.8	2049.8	0.0	2049.8	2049.8	0.0	2049.8	2049.8	6149.4
SYS DOCUMNTATION	410.0	0.0	410.0	410.0	0.0	410.0	410.0	0.0	410.0	1230.0
SYS TEST+EVAL	276.0	827.9	1103.9	113.0	338.9	451.9	78.7	236.2	314.9	1870.7
TRAINING	0.0	56.0	56.0	0.0	44.8	44.8	0.0	44.8	44.8	145.6
MATERIEL SUP	301.5	0.0	301.5	169.3	0.0	169.3	233.5	0.0	233.5	704.3
TTL INVESTMNT COST	20016.4	2471.2	22487.6	8511.5	1823.5	10335.0	5848.4	1911.2	7759.6	40582.2
ADPE PROC	14460.0	0.0	14460.0	5700.0	0.0	5700.0	3900.0	0.0	3900.0	24060.0
SYS SFTWARE PROC	723.0	0.0	723.0	570.0	0.0	570.0	390.0	0.0	390.0	1683.0
SFTWARE DEV	0.0	1038.0	1038.0	0.0	1038.0	1038.0	0.0	1038.0	1038.0	3114.0
TEMPEST SECURITY	2169.0	0.0	2169.0	855.0	0.0	855.0	585.0	0.0	585.0	3609.0
SYS DOCUMNTATION	207.6	0.0	207.6	207.6	0.0	207.6	207.6	0.0	207.6	622.8
FILE CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	210.0	210.0	210.0
FACILITIES ACTIV	730.8	313.2	1044.0	448.0	142.0	590.0	235.2	100.8	336.0	1970.0
TRAINING	280.0	1120.0	1400.0	160.9	643.5	804.4	140.6	562.4	703.0	2907.4
MATERIEL SUP	1446.0	0.0	1446.0	570.0	0.0	570.0	390.0	0.0	390.0	2406.0
TTL OPERATING COST	5636.9	13352.0	18988.9	8760.3	76378.8	85139.1	12912.6	68952.3	81864.9	185992.9
SYS MGT+OPS	0.0	0.0	0.0	0.0	51985.0	51985.0	0.0	47887.0	47887.0	99872.0
ADPE MAINT	0.0	1446.0	1446.0	0.0	10688.8	10688.8	0.0	8541.2	8541.2	20676.0
SFTWARE MAINT	0.0	1928.0	1928.0	0.0	1928.0	1928.0	0.0	1928.0	1928.0	5784.0
DOCUMENTATION	385.6	0.0	385.6	385.6	0.0	385.6	385.6	0.0	385.6	1156.8
FACILITIES SUP	0.0	6618.0	6618.0	0.0	9846.0	9846.0	0.0	8909.1	8909.1	25373.1
TRAINING	840.0	3360.0	4200.0	483.0	1931.0	2414.0	422.0	1687.0	2109.0	8723.0
MATERIEL SUP	1146.3	0.0	1146.3	4626.7	0.0	4626.7	8840.0	0.0	8840.0	14613.0
COMMUNICATIONS	3265.0	0.0	3265.0	3265.0	0.0	3265.0	3265.0	0.0	3265.0	9795.0

Table 10

DISHIER LIFE CYCLE COST SCHEDULE
(Dollars in Thousands)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
LIFE CYCLE COST	1623.7	5625.7	7009.2	15720.7	37395.6	25718.4	18973.0	18973.0	18973.0	18973.0
TTL DEVELPMNT COST	1623.7	5625.7	7009.2	4043.6	0.0	0.0	0.0	0.0	0.0	0.0
SYS RESEARCH	442.9	332.2	221.5	110.7	0.0	0.0	0.0	0.0	0.0	0.0
ENG DEVELPMNT	0.0	720.0	960.0	720.0	0.0	0.0	0.0	0.0	0.0	0.0
PROTOTYPE SYS	0.0	1878.0	2816.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SFTWARE DEV	984.8	1721.8	1721.8	1721.8	0.0	0.0	0.0	0.0	0.0	0.0
SYS DOCUMNTATION	196.8	344.4	344.4	344.4	0.0	0.0	0.0	0.0	0.0	0.0
SYS TEST+EVAL	0.0	373.9	561.4	935.4	0.0	0.0	0.0	0.0	0.0	0.0
TRAINING	0.0	58.2	87.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MATERIEL SUP	0.0	197.2	295.8	211.3	0.0	0.0	0.0	0.0	0.0	0.0
TTL INVESTMNT COST	0.0	0.0	0.0	11677.1	18796.3	7119.2	373.7	373.7	373.7	373.7
ADPE PROC	0.0	0.0	0.0	7218.0	12030.0	4812.0	0.0	0.0	0.0	0.0
SYS SFTWARE PROC	0.0	0.0	0.0	504.9	841.5	336.6	0.0	0.0	0.0	0.0
SFTWARE DEV	0.0	0.0	0.0	0.0	311.4	311.4	311.4	311.4	311.4	311.4
TEMPEST SECURITY	0.0	0.0	0.0	1082.7	1804.5	721.8	0.0	0.0	0.0	0.0
SYS DOCUMNTATION	0.0	0.0	0.0	0.0	62.2	62.2	62.3	62.3	62.3	62.3
FILE CONVERSION	0.0	0.0	0.0	105.0	105.0	0.0	0.0	0.0	0.0	0.0
FACILITIES ACTIV	0.0	0.0	0.0	591.0	985.0	394.0	0.0	0.0	0.0	0.0
TRAINING	0.0	0.0	0.0	1453.7	1453.7	0.0	0.0	0.0	0.0	0.0
MATERIEL SUP	0.0	0.0	0.0	721.8	1203.0	481.2	0.0	0.0	0.0	0.0
TTL OPERATING COST	0.0	0.0	0.0	0.0	18599.3	18599.2	18599.3	18599.3	18599.3	18599.3
SYS MGT+OPS	0.0	0.0	0.0	0.0	9987.2	9987.2	9987.2	9987.2	9987.2	9987.2
ADPE MAINT	0.0	0.0	0.0	0.0	2067.6	2067.6	2067.6	2067.6	2067.6	2067.6
SFTWARE MAINT	0.0	0.0	0.0	0.0	578.4	578.4	578.4	578.4	578.4	578.4
DOCUMENTATION	0.0	0.0	0.0	0.0	115.6	115.6	115.7	115.7	115.7	115.7
FACILITIES SUP	0.0	0.0	0.0	0.0	2537.4	2537.3	2537.3	2537.3	2537.3	2537.3
TRAINING	0.0	0.0	0.0	0.0	872.3	872.3	872.3	872.3	872.3	872.3
MATERIEL SUP	0.0	0.0	0.0	0.0	1461.3	1461.3	1461.3	1461.3	1461.3	1461.3
COMMUNICATIONS	0.0	0.0	0.0	0.0	979.5	979.5	979.5	979.5	979.5	979.5

Table 10 (Concluded)

	1988	1989	1990	1991	TOTAL LCC
LIFE CYCLE COST	18973.0	18973.0	18973.0	18973.0	244877.3
TTL DEVELPMNT COST	0.0	0.0	0.0	0.0	18302.2
SYS RESEARCH	0.0	0.0	0.0	0.0	1107.3
ENG DEVELPMNT	0.0	0.0	0.0	0.0	2400.0
PROTOTYPE SYS	0.0	0.0	0.0	0.0	4694.9
SFTWARE DEV	0.0	0.0	0.0	0.0	6149.4
SYS DOCUMNTATION	0.0	0.0	0.0	0.0	1230.0
SYS TEST+EVAL	0.0	0.0	0.0	0.0	1870.7
TRAINING	0.0	0.0	0.0	0.0	145.6
MATERIEL SUP	0.0	0.0	0.0	0.0	704.3
TTL INVESTMNT COST	373.7	373.7	373.7	373.7	40582.2
ADPE PROC	0.0	0.0	0.0	0.0	24060.0
SYS SFTWARE PROC	0.0	0.0	0.0	0.0	1683.8
SFTWARE DEV	311.4	311.4	311.4	311.4	3114.0
TEMPEST SECURITY	0.0	0.0	0.0	0.0	3609.0
SYS DOCUMNTATION	62.3	62.3	62.3	62.3	622.8
FILE CONVERSION	0.0	0.0	0.0	0.0	210.0
FACILITIES ACTIV	0.0	0.0	0.0	0.0	1970.0
TRAINING	0.0	0.0	0.0	0.0	2907.4
MATERIEL SUP	0.0	0.0	0.0	0.0	2406.0
TTL OPERATING COST	18599.3	18599.3	18599.3	18599.3	185992.9
SYS MGT+OPS	9987.2	9987.2	9987.2	9987.2	99872.0
ADPE MAINT	2067.6	2067.6	2067.6	2067.6	20676.0
SFTWARE MAINT	578.4	578.4	578.4	578.4	5784.0
DOCUMENTATION	115.7	115.7	115.7	115.7	1156.8
FACILITIES SUP	2537.3	2537.3	2537.3	2537.3	25373.1
TRAINING	872.3	872.3	872.3	872.3	8723.0
MATERIEL SUP	1461.3	1461.3	1461.3	1461.3	14613.0
COMMUNICATIONS	979.5	979.5	979.5	979.5	9795.0

1. DISHIER Development Cost

As shown in Table 9, the projected development cost for DISHIER is $18,302,200. This projection is based on analysis of typical development costs for ADPS configurations, with the following assumptions:

- The research and development phase will require 4 years prior to the initial operating capability of field systems.
- A major strategy of the research and development phase will be the development, laboratory exercise, and field exercise of a prototype configuration.
- ADPE to be tested and analyzed (and later procured during the investment process) will come from the regular product line of the contracted manufacturer (that is, the ADPE will be "off-the-shelf" with only minor modification to suit the requirements of the FMF).

An assumed scenario for the chronology of the activities of the research and development phase is presented in Table 11. Based on these assumptions, the component cost elements of the total development cost are addressed in the subsections below.

a. Systems Research Cost

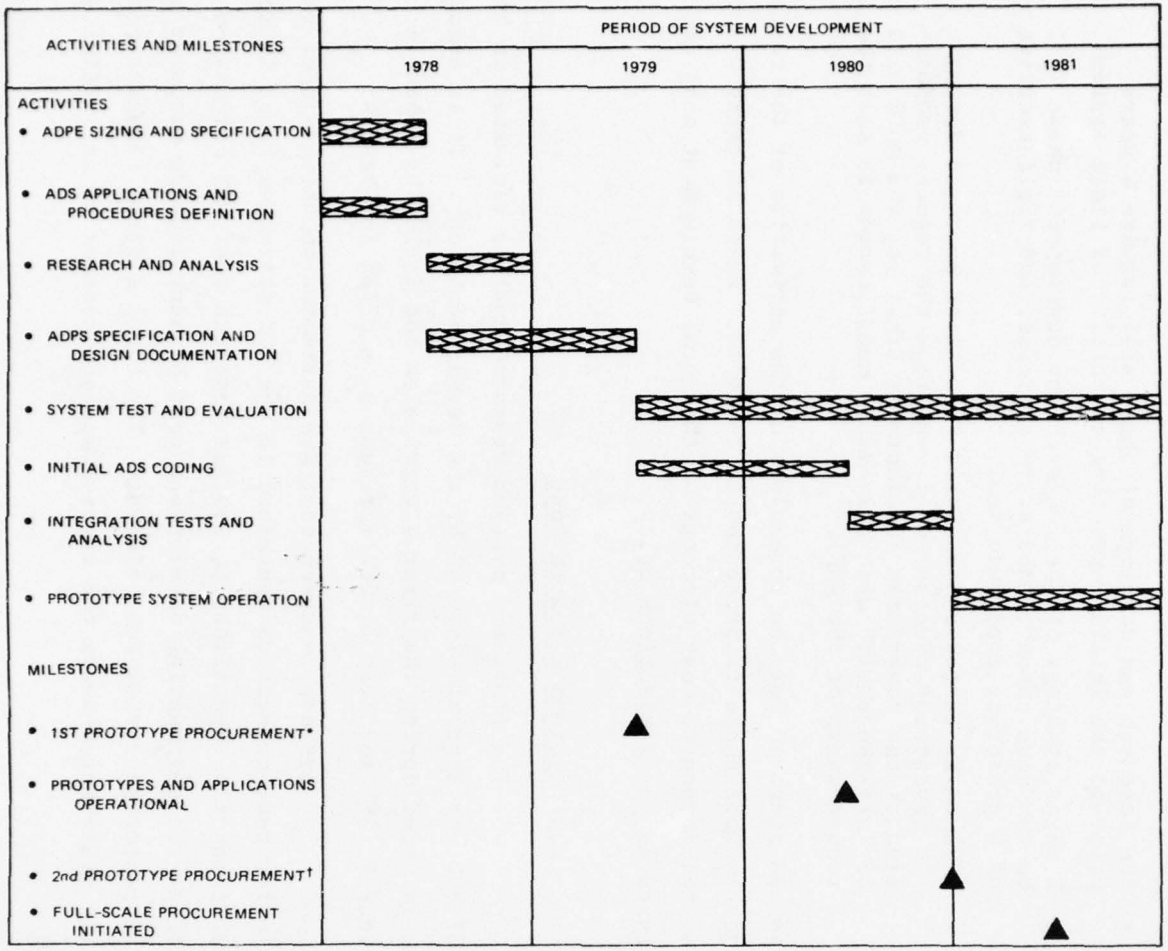
The projected systems research cost is estimated to be $1,107,300, or approximately 6% of the development cost. It is assumed to be incurred during the first 4 years with the following schedule: 40% for Year 1, 30% for Year 2, 20% for Year 3, and 10% for Year 4.

Systems research cost was estimated on the basis of ratios of similar cost categories contained in the LCC estimates found in References 11 and 13. Specifically, systems research cost was calculated to be 24% of the engineering development cost element and the manpower portion of the prototype system cost element. The total systems research cost was equally distributed among the three component systems as an initial estimate.

b. Engineering Development Cost

The projected engineering development cost for DISHIER is estimated to be $2,400,000, or approximately 13% of the development cost.

TABLE 11
SCENARIO FOR ADPS DEVELOPMENT



* Procurement includes ADPE and software for 1 System C and 5 System A's.

† Procurement includes ADPE and software for 2 System B's and 15 System A's.

It is assumed to be incurred for 3 years beginning with the second year according to the following schedule: 30% for Year 2, 40% for Year 3, and 30% for Year 4.

Engineering development cost was estimated on the basis of the number of engineering man-years that would be required for the development activities. Based on a level of effort analogous to that for similar ADPS (see Reference 13), it was projected that 40 engineering man-years would be required and that each contracted man-year would cost $60,000. The total engineering development cost was equally distributed among the three component systems as an initial estimate.

c. Prototype System Cost

The projected prototype system cost for DISHIER is estimated to be $4,694,900, or approximately 26% of the development cost. It is assumed to be incurred for 3 years beginning with the second year. Yearly costs are based on the schedule presented in Table 11.

Prototype systems cost was estimated on the basis of procuring and manning the following component systems:

- 1 System C purchased in Year 2 and exercised for development purposes for 2 1/2 years with the following manning complement:
  - 1 systems programmer ($31K/year)
  - 1 senior analyst/programmer ($39K/year)
  - 2 analyst/programmers ($28K/year)
  - 6 ADPE operators (20K/year)
  - 2 ADPE maintenance men ($21K/year).
- 2 System Bs purchased in Year 3 and exercised for development purposes for 1 year with the following manning complement per system:
  - 1 senior analyst/programmer ($39K/year)
  - 4 ADPE operators ($20K/year)
  - 1 ADPE maintenance man ($21K/year).
- 20 System As--5 purchased in Year 2 and exercised for 2 1/2 years, and 15 purchased in Year 3 and exercised for 1 year --each with the following manning complement:
  - 2 representative users ($20K/year).

The procurement of the component systems included the cost of purchasing the ADPE, as well as the cost of purchased software. A breakdown of these costs are found in Paragraphs III.B.2.a and III.B.2.b. Furthermore, the total personnel costs for Systems C and B above were inflated by 33% to account for extra personnel who would be required to maintain a full staff throughout the entire work year (that is, fill in for personnel on leave, and so on).

d. Software Development Cost

The projected software development cost for DISHIER is estimated to be $6,149,400, or approximately 34% of the development cost. It is assumed to be incurred during the first 4 years, with the yearly cost based on SRI's estimate of a representative number of staff that would be required to carry out the software development activities.

Software development cost was estimated on the basis of providing the following complement of personnel to work on development tasks:

- 20 senior analyst/programmers ($34K/year)
- 15 senior systems programmers ($36K/year)
- 3 ADPE operators ($20K/year)
- 1 ADPE maintenance man ($21K/year)
- 5 representative users ($20K/year).

SRI assumed that only half this complement would be engaged in the first year, but that the full complement would be engaged during the succeeding 3 years. Furthermore, the total personnel costs were inflated by 33% to account for extra personnel who would be required to maintain a full staff throughout the entire work year (that is, fill in for personnel on leave, and so on). The total software development cost was equally distributed among the three component systems as an initial estimate.

e. System Documentation Cost

The projected system documentation cost is estimated to be $1,230,000, or approximately 7% of the development cost. It is assumed

to be incurred during the first 4 years, with the yearly cost being compatible with the software development yearly cost.

System documentation cost, estimated on the basis of SRI experience, was placed at 20% of the software development cost element. The total system documentation cost was equally distributed among the three component systems as an initial estimate.

f. System Test and Evaluation Cost

The projected system test and evaluation cost is estimated to be $1,870,700, or approximately 10% of the development cost. It is assumed to be incurred for 3 years beginning with the second year, and subject to the following schedule: 20% for Year 2, 30% for Year 3, and 50% for Year 4.

System test and evaluation cost was estimated on the basis of ratios of similar cost categories contained in the LCC estimates found in References 11 and 13. Specifically, it was calculated to be 7% of the ADPE procurement cost element and the equipment portion of the prototype system cost element. The system test and evaluation cost was distributed among the component systems according to the ratio of their ADPE procurement costs; it was split among equipment and manpower costs based on an engineering estimate of 25% for equipment and 75% for manpower.

g. Training Cost

The projected training cost is estimated to be $145,600 or approximately 1% of the development cost. It is assumed to be incurred concurrently or slightly preceding the purchase of prototype ADPE; hence, it appears during the second and third years.

Training cost was estimated as the product of the number of personnel who would be involved in operations and maintenance of the prototype ADPS configuration, and the cost to train each of these personnel. Since salary, burden, and basic background training (such as a basic electronics course) is included in the man-year billet costs that SRI associated with each system, only the cost of organizing and delivering specialized

courses is included in the training cost. References 7, 11, and 13, as well as direct quotations from ADPE manufacturers, indicated that a week of such training would cost approximately $700. Based on SRI's estimate of the number of weeks required to train individual skill types (see Appendix A), a representative period of 4 weeks was chosen for all skill categories; therefore, SRI accounted a cost of $2800 per individual trained.

h. Materiel Support Cost

The projected materiel support cost is estimated to be $704,300, or approximately 4% of the development cost. It is assumed to be incurred concurrently with the exercising of the prototype ADPS, so that it appears during the second, third, and fourth years.

Materiel support cost was estimated on the basis of ratios of similar cost categories contained in the LCC estimates found in References 11 and 13. Specifically, materiel support cost was calculated to be 15% of the prototype system cost element with the breakdown being 15% of the prototype ADPE purchase for spares and repair parts, and 15% of the prototype operations and maintenance manpower cost for supplies.

2. DISHIER Investment Cost

As shown in Table 9, the projected investment cost for DISHIER is $40,582,200. This projection is based on analysis of typical investment costs for ADPS configurations, with the following assumptions:

- ADPE will come from the regular product line of a manufacturer (that is, the ADPE will be "off-the-shelf" with only minor modification to suit the requirements of the FMF).
- ADPE will be purchased rather than leased.

Based on these assumptions the component cost elements of the total investment cost are addressed in the paragraphs that follow.

a. ADPE Procurement

The projected ADPE procurement cost is estimated to be $24,060,000, or approximately 59% of the total investment cost. It is

assumed that this cost will be incurred beginning in the fourth year (to have the initial IOC at the beginning of the fifth year) and continue through the fifth and sixth years according to the following schedule: 30% for Year 4, 50% for Year 5, and 20% for Year 6.

ADPE procurement cost was estimated on the basis of direct manufacturer quotation of present systems with similar generic capabilities as those contained in the component ADPS configurations in DISHIER. Table 12 presents the cost breakdown of individual system elements that SRI compiled from discussions with numerous manufacturers.[17] It should also be stated that the costs presented for the component systems in Table 12 represent the cost of "militarized" or "ruggedized" systems, and they are quoted for a quantity purchase of one.

The extrapolation premise that SRI used to project the cost of the ADPE 5 years from now was that the present day prices would be reduced by half for quantity purchases (on the order of 100 or more) such as those that would be required for the DISHIER concept. On that basis, the actual figures used in the LCC model were:

- System A ($60K)--quantity of 261 (20 of which were already purchased as prototype systems).
- System B ($150K)--quantity of 40 (2 of which were already purchased as prototype systems).
- System C ($300K)--quantity of 14 (1 of which was already purchased as a prototype system).

b. System Software Procurement Cost

The projected system software procurement cost is estimated to be $1,683,000, or approximately 4% of the total investment cost. It is assumed that this cost will be incurred beginning in the fourth year and will parallel the ADPE procurement schedule of: 30% for Year 4, 50% for Year 5, and 20% for Year 6.

System software procurement cost was estimated on the basis of ratios of similar cost categories contained in the LCC estimates found in References 11 and 13. Specifically, system software procurement cost

Table 12

CURRENT ADPE COST BREAKDOWN
(Dollars in Thousands)

ADPE Component	System A Cost*	System B Cost*	System C Cost*
Standard CPU and Main Memory	45.0	125.0	265.0
Mass Storage Device	24.0	35.0	55.0
Interactive I/o Device	16.0	64.0	128.0
Hardcopy Output Device	16.0	64.0	128.0
Telecommunications Interface	1.5	1.5	1.5
Removable Data Medium	11.0	11.0	22.0
	113.5	300.5	599.5

*Cost estimate is based on current "ruggedized" or "militarized" ADPE for a quantity of one purchase.

was calculated to be 5% of the ADPE procurement cost element for System A and 10% of the ADPE procurement cost element for System B and System C.

c. Software Development Cost

The projected software development cost is estimated to be $3,114,000, or approximately 8% of the total investment cost. It is assumed that this cost will be incurred continuously during the operational lifetime of DISHIER according to a schedule of 10% per year for 10 years.

Software development cost was estimated on the basis of providing the following complement of personnel to work on development tasks:

- 12 senior analyst/programmers ($34K/year)
- 5 senior systems programmers ($36K/year)
- 3 ADPE operators ($20K/year)
- 1 ADPE maintenance man ($21K/year)

SRI assumed that only 35% of this complement would be engaged in actual software development (the other 65% of effort being expended for software maintenance). However, the total personnel costs were inflated by 33% to account for extra personnel who would supplement those listed above to maintain a full staff during the entire working year, (that is, fill in for personnel on leave, and so on). In effect then, the costs reflect a staff of 28 rather than 21. The total software development cost was equally distributed among the three component systems as an initial estimate.

d. TEMPEST Security

The projected TEMPEST security cost is estimated to be $3,609,000, or approximately 9% of the total investment cost. It is assumed that it will be incurred concurrently with the ADPE procurement schedule of: 30% for Year 4, 50% for Year 5, and 20% for Year 6.

TEMPEST security cost was estimated on the basis of SRI consultations with experienced TEMPEST engineers. Specifically, the cost was placed at 15% of the ADPE procurement cost elements. This overall estimate is based on the assumption that a variety of least-cost items including shelters and equipment modifications, would be used.

e. System Documentation Cost

The projected system documentation cost is estimated to be $622,800, or approximately 2% of the total investment cost. It is assumed that this cost will be incurred continuously during the operational lifetime of DISHIER according to a schedule of 10% per year for 10 years.

System documentation cost, estimated on the basis of SRI experience, was placed at 20% of the software development cost element. The total system documentation cost was equally distributed among the three component systems as an initial estimate.

f. File Conversion Cost

The projected file conversion cost is estimated to be $210,000, or approximately 1% of the total investment cost. It is assumed that this cost will be incurred at the time of initial implementation of DISHIER as an operational system; hence, it has been assigned the following schedule: 50% for Year 4 and 50% for Year 5.

File conversion cost was estimated on the basis of an SRI estimate that it would take approximately 7.5 man-years of analyst/programmer effort ($28K/year) to complete the required file conversions. In this estimate, SRI assumed that 6 man-months would be adequate per system, and that there was a maximum of 15 systems whose files must be converted.

g. Facilities Activation Cost

The projected facilities activation cost is estimated to be $1,970,000, or approximately 5% of the total investment cost. It is assumed that this cost will be incurred concurrently with the ADPE procurement schedule of: 30% for Year 4, 50% for Year 5, and 20% for Year 6.

Facilities activation cost was estimated on the basis of information assembled from References 11 and 13. Specifically, each System A activation was assumed to cost $4K, and each System B and System C activation was assumed to cost $8K. Additionally, provision was made for each System B to have one shelter at a cost of $8K, and each System C to have two shelters at a cost of $16K per system.

h. Training Cost

The projected training cost is estimated to be $2,907,400, or approximately 7% of the total investment cost. It is assumed to be incurred to coincide with the initial operating capability of the ADPE; hence, it follows the schedule: 50% for Year 4 and 50% for Year 5.

Training cost was estimated on the basis of the number of personnel who would: (1) be involved in the operations and maintenance of the ADPE, and (2) be involved in the use of the ADPE. References 7, 11

and 13, as well as direct quotations from ADPE manufacturers indicated that the cost of a week of training was approximately $700 over and above the billet costs of 540 Marines involved in ADP. Based on SRI's estimate of the number of weeks required to train individual skill types (see Appendix A), a representative period of 4 weeks was chosen for all operations and maintenance positions; therefore, SRI accounted a cost of $2800 per individual trained in ADP operations and maintenance. SRI further estimated that 1 week was sufficient to train functional and administrative users of the ADPE. The number of users was estimated at 2000.

i. Materiel Support Cost

The projected materiel support cost is estimated to be $2,406,000, or approximately 6% of the total investment cost. It is assumed that this cost will be incurred at the time of ADPE procurement according to the schedule: 30% for Year 4, 50% for Year 5, and 20% for Year 6.

Materiel support cost was estimated on the basis of ratios of similar cost categories contained in the LCC estimates found in References 11 and 13. Specifically, materiel support cost was calculated to be 10% of the ADPE procurement cost element.

3. DISHIER Operating Cost

As shown in Table 9, the projected operating cost for DISHIER is $185,992,900. This projection is based on analysis of typical operating costs for ADPS configurations, with the following assumptions:

- The operational lifetime of the system will be 10 years from the IOC of the first systems to be fielded.
- Operating costs will be incurred continuously during the operational lifetime according to a schedule of 10% per year for 10 years.

The component cost elements of the total operating cost are addressed in the paragraphs below.

a. System Management and Operations

The projected system management and operations cost is estimated to be $99,872,000, or approximately 54% of the total operating cost.

System management and operations cost was estimated as the product of the 429 analyst/programmers, systems programmers, and ADPE operators that would be required to staff the DISHIER ADP systems, and their billet costs as identified in Table 13. Billet costs were taken from Reference 4 and adjusted to make that data current to 1977. Billet costs contain all salary and burden costs that can be ascribed to the LCC of each Marine of a particular rank and occupational specialty.

b. ADPE Maintenance Cost

The projected ADPE maintenance cost is estimated to be $20,676,000, or approximately 11% of the total operating cost.

One portion of the ADPE maintenance cost was estimated as the product of the 83 ADPE maintenance men who would be required to staff the DISHIER ADP systems, and the associated cost of each ADPE maintenance billet, also shown in Table 13. The second portion was estimated on the basis of a contractor maintenance cost of 1% per year for 10 years.

c. Software Maintenance Cost

The projected software maintenance cost is estimated to be $5,784,000, or approximately 3% of the total operating cost.

Software maintenance cost was estimated on the basis of providing the following complement of personnel to work on development tasks:

- 12 senior analyst/programmers ($34K/year)
- 5 senior systems programmers ($36K/year)
- 3 ADPE operators ($20K/year)
- 1 ADPE maintenance man ($21K/year).

Table 13

ADPS PERSONNEL BILLET COSTS
(Cost in $1000)

ADP Job Category	Officer Billets			Enlisted Billets		
	Percent of Total	Primary Grades	Annual Cost	Percent of Total	Primary Grades	Annual Cost
Analyst/programmer	50%	01-02	$34.0	50%	E4-E5	$23.0
Senior analyst/programmer	50	02-04	44.0	50	E7-E8	34.0
Systems programmer	25	01-02	28.0	75	E5-E6	28.0
Senior systems programmer	50	03-04	34.0	50	E7-E8	34.0
ADPE operator	0	---	---	100	E2-E4	20.0
ADPE maintenance	0	---	---	100	E3-E5	21.0

SRI assumed that only 65% of this complement would be engaged in actual software maintenance (the other 35% of effort being expended for software development). However, the total personnel costs were inflated by 33% to account for extra personnel who would supplement those listed above to maintain a full staff during the entire working year, (that is, fill in for personnel on leave, and so on). In effect then, the costs reflect a staff of 28 rather than 21. The total software maintenance cost was equally distributed among the three component systems as an initial estimate.

d. Documentation Cost

The projected documentation cost is estimated to be $1,156,800, or approximately 1% of the total operating cost.

Documentation cost was estimated, on the basis of SRI experience, to be 20% of the software maintenance cost. The total documentation cost was equally distributed among the three component systems as an initial estimate.

e. Facilities Support Cost

The projected facilities support cost is estimated to be $25,373,100, or approximately 14% of the total operating cost.

Facilities support cost was estimated on the basis of ratios of a similar cost category contained in the LCC estimates of Reference 13. Specifically, facilities support cost was calculated to be 15% of the combined costs of the software development, system management and operations, ADPE maintenance, and software maintenance cost elements.

f. Training Cost

The projected training cost is estimated to be $8,723,000, or approximately 5% of the total operating cost.

Training cost was estimated on the basis of an SRI estimate of an approximate 30% yearly turnover in ADP job categories; hence, it

was calculated to be 30% of the training cost element (accounted for under the investment cost) per year for the 10-year lifetime.

g. Materiel Support Cost

The projected materiel support cost is estimated to be $14,613,000, or approximately 8% of the total operating cost.

Materiel support cost was estimated on the basis of ratios of similar cost categories contained in the LCC estimates found in References 11 and 13. Specifically, materiel support cost was calculated to be 5% of the ADPE procurement cost element for spares and repair parts, plus 17% of the combined costs of the system management and operations, software maintenance, and software development cost elements for supplies.

h. Communications Cost

The projected communications cost is estimated to be $9,795,000, or approximately 5% of the total operating cost.

Communications cost was estimated on the basis of ratios of a similar cost category contained in the LCC cost estimates of Reference 13. Specifically, communications cost was calculated to be 4% of the total DISHIER LCC. The total communications cost was equally distributed among the three component systems as an initial estimate.

4. Cost Perspectives

As a means of summarizing, interpreting, and ascertaining the importance of various elements and components of the DISHIER LCC, two additional pieces of information are presented in Table 14 and Figure 7. Table 14 addresses the relative impact on the DISHIER LCC of the three LCC phases, the three component systems, and the manpower and equipment resources. Figure 7 graphically presents the profile of annual expenditures required to develop, operate, and maintain the DISHIER concept over its life cycle.

Table 14

DISHIER COST-ELEMENT PERSPECTIVES

Cost Element	Percent of DISHIER LCC
LCC Phases	
• Development	7.5%
• Investment	16.6
• Operations	75.9
Component Systems	
• System A	19.8
• System B	41.2
• System C	39.0
Resources	
• Equipment	27.3
• Manpower	72.7

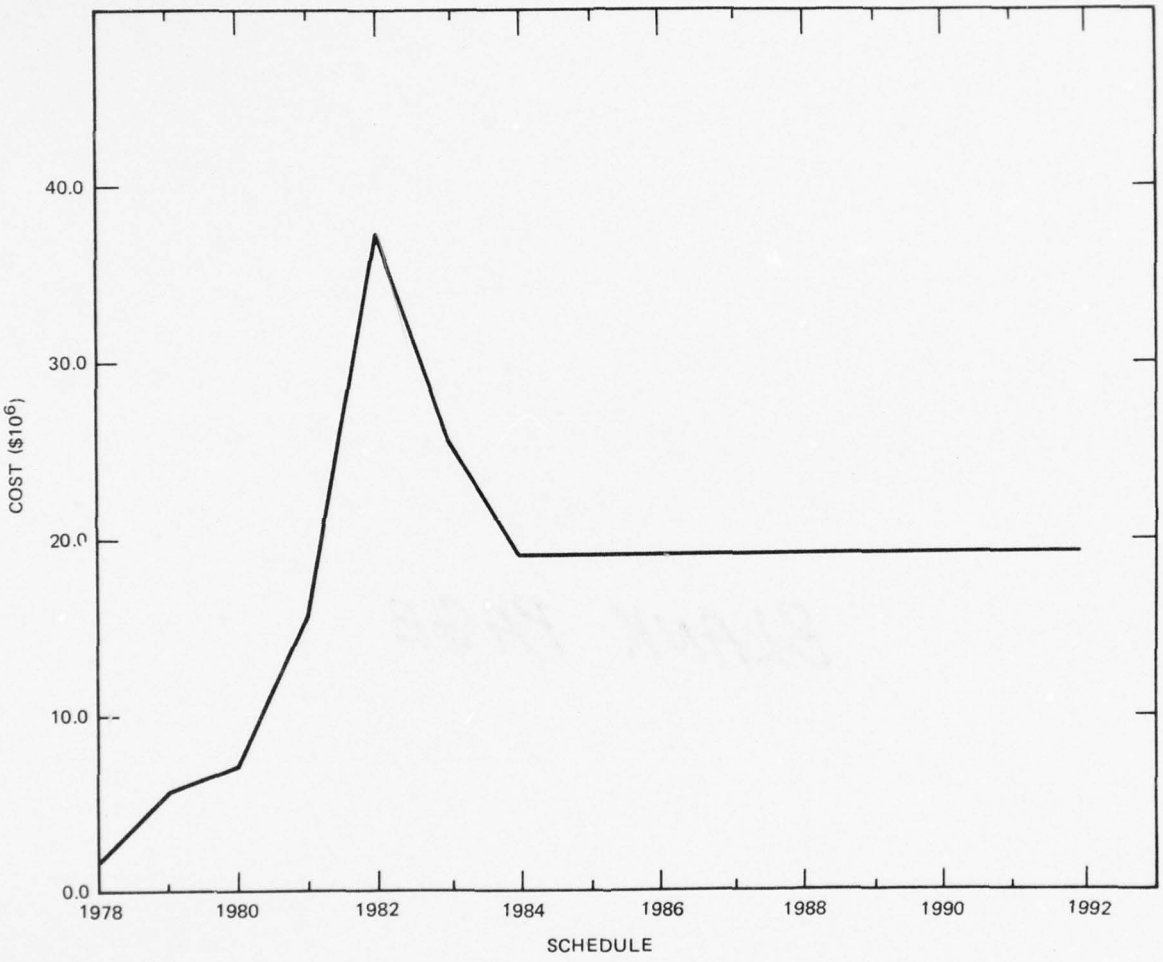


FIGURE 7 ANNUAL DISHIER LCC EXPENDITURES

IV DISACT LIFE CYCLE COSTS

The cost estimates presented in this section are for the Distributed Activity (DISACT) ADPS concept that is described in detail in Volume IV of this study report. To provide a point of reference, this section begins with a brief overview of the DISACT concept. Following that, each of the life cycle cost elements that occur as components of the development, investment, or operating costs of the ADPS LCC are addressed, and assumptions and sources of data are identified that influenced the calculation of the separate elements.

A. Concept Overview

1. System Logic

DISACT provides workload-associated computing power to the FMF from the highest command level down to the battalion/squadron level. Processing resources range from large variable-configuration minicomputer systems at FMFPAC/FMFLANT level through minicomputer based systems for activities with large workloads, to small stand-alone micro-processor systems for activities with smaller workloads. The system logic connecting the computer resources at the various activities is mutually supporting within a particular combat element (air, ground, CSS). Accordingly, in the vertical workload and processing resource, requirements of the separate combat elements create differences in the topology of APA systems as they are conceived for air, ground, and CSS.

The physical size and support requirements of the component systems do not unduly constrain the support capabilities and mobility requirements of the units they support. Hence, deployed MAGTFs can be supported afloat/ashore using equipment and procedures that also serve their garrison requirements.

DISACT provides modularity through the mix of component systems that differ in size, capacity, and function. The flexibility inherent in such resources allows DISACT to accomodate readily different MAGTF configurations (MAF, MAB, and MAU), as well as differing intensities of operations.

DISACT is designed to support the flow of administrative information (manpower, operations, logistics, financial) within the FMF and from FMF to higher headquarters. This is achieved through an SDA-like capability to capture information in machine-readable form close to the source. That capability is augmented by editing, validating, summarization, and aggregation capabilities within each combat element, as well as the ability to transmit the reporting information up and down the organization chain.

Vertical information flow paths exist between successive echelons in DISACT. Each of these consists of one or more two-way electronic data transmission links (through LFICS). In the absence of such links, digital data on machine-readable media (such as cassettes or floppy disks) can be physically transported from point to point via any suitable transportation means.

DISACT further provides functional capabilities to meet the local units' internal command and management information processing requirements. These capabilities (such as local inquiry, retrieval, update, and sort) are tailored to correspond to the nature and the volume of the workload at each echelon level and the other levels it may support. The use and access to these capabilities are oriented toward actual users of the information rather than a data processing intermediary.

Serving simultaneously the reporting and local usage requirements, DISACT is in every sense a generalized management tool. It is a tool that is shared among the functional management areas (manpower, operations, and training logistics, and finance)--serving the particular needs of the unit, rather than those of one functional area. As such, the capability DISACT provides must be shared among a group of users according to the need and priority to be established at each echelon.

Figure 8 outlines the ADP system and organizational relationship for DISACT in a deployed MAGTF. Immediately apparent in the overview is the dissimilarity among the distributions of ADS resources in the three combat elements. The orientation of the air and CSS elements toward equipment, supply, and maintenance (rather than toward manpower as in the ground element) drives the DISACT rationale for expanded computing power in the middle of the echelon hierarchy. It is at this point that the logistics functions of supply, maintenance, and equipment readiness came to a focus. By placing expanded computing power in the middle echelon, DISACT attempts to accomodate the largest workload close to its source.

2. System Implementation

DISACT consists of a mix of component computer systems that provide workload-tailored computing power to the FMF. Three generic component systems provide the differences in size, capacity, and function that accommodate the varying workloads of the different activities of the FMF. Within each combat element, the component systems are vertically integrated in the sense that their capabilities for data capture, manipulation, and retrieval of information flowing from the lowest echelons upward and, in some cases, to the Supporting Establishment are distinct but mutually supportive of the total management needs of the combat element.

The rationale for distributing the component computer systems among the FMF units is based on accommodating the natural workload at a facility internal to the activity where it occurs. That is, the greatest workloads emanate from FMF warehouses and maintenance activities, rather than from command offices. This approach is modified to the minimum degree to accommodate the technology and its ability to match the ADP equipment size, mobility, support requirements, and functional capability to the actual unit where it resides. A summary of the component systems contained in DISACT is contained in Table 15, along with an overview of the system functions that they provide.

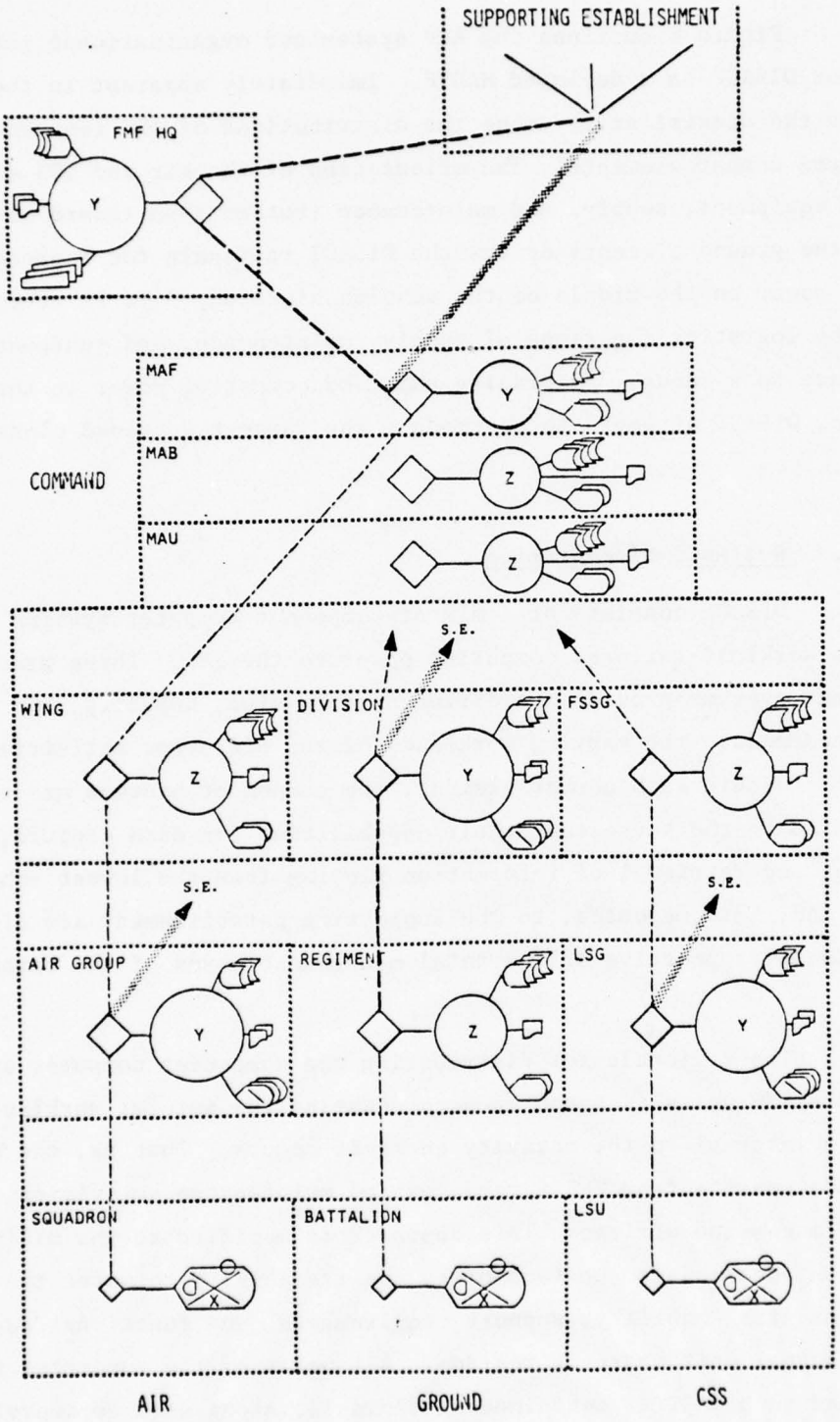
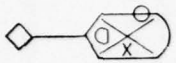
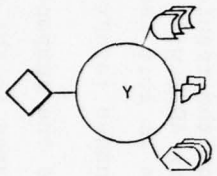
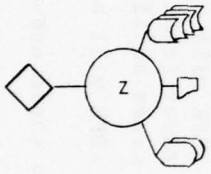


FIGURE 8 DISACT OVERVIEW

Table 15

DISACT ADPS IMPLEMENTATION

Component Systems	Hardware Characteristics	System Software Features*	Supported System Functions
 System X	Micro-processor based system Programmable or PROM processor RAM main storage Auxiliary storage Keyboard/display input device Hardcopy output device Telecommunications interface Removable magnetic I/O medium	Control program System utilities Application language processors System diagnostic routines Preprogrammed applications Text handler	Data capture, verification, and editing Simple word and text processing Simple file management of small files Simple information storage and retrieval Numerical calculation Report formatting System self-diagnosis Data communication
 System Y	Mini-processor system--variable configuration Multiprogramming processor hardware Ample main storage Extensive auxiliary storage Multiple keyboard/display input devices Multiple hardcopy printers Telecommunications interface Removable magnetic I/O medium	Operating system for batch & interactive processing Report generator program Preprogrammed applications Query language Rudimentary programming aids Data management package	Foreground/background processing Sophisticated storage and retrieval Data management Report generation Data communication Activity oriented applications
 System Z	Mini-processor based system Programmable processor Multiprogramming processor hardware Sizeable main and auxiliary storage Multiple keyboard/display input devices Multiple hardcopy printers Telecommunications interface Removable magnetic I/O medium	Multiprogramming operating system Compilers for high-level languages Utility program library Diagnostic program package Data management package	Multiprogramming and interactive processing String processing General data base management Interoperability interfaces High speed, high volume data communication

*It is anticipated that many of these features may be implemented in firmware.

B. Cost Estimate Review

The total LCC estimated for the DISACT concept is summarized in the computer output of the SRI LCC model in Tables 16 and 17. As shown in the summary totals of those tables, DISACT is projected to cost $334,330,800. The cost is to be incurred over a 14-year period that includes a 4-year development phase and a 10-year operational lifetime.

1. DISACT Development Cost

As shown in Table 16, the projected development cost for DISACT is $18,493,600. This figure was arrived at using the same approach and logic that governed the estimate of the DISHIER development cost. That action was taken because there appears to be no major differences in the development cost between the two systems--at least to the fidelity of the estimates contained in this report. The reader is, therefore, referred to the development cost description above in Part III.B.1. It should be noted, however, that the following associations must be made when comparing DISHIER and DISACT data: DISHIER's System A is generically similar to DISACT's System X; DISHIER's System B is generically similar to DISACT's System Z; DISHIER's System C is generically similar to DISACT's System Y.*

2. DISACT Investment Cost

As shown in Table 16, the projected investment cost for DISACT is $45,217,500. This projection is based on analysis of typical investment costs for ADPS configurations, with the following assumptions:

- ADPE will come from the regular product line of a manufacturer (that is, the ADPE will be "off-the-shelf" with only minor modification to suit the requirements of the FMF).
- ADPE will be purchased rather than leased.

Based on these assumptions the component cost elements of the total investment cost are addressed in the paragraphs that follow.

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*These associations have been assumed throughout this cost analysis with respect to component system costs. That is, Systems A and X have the same cost; Systems B and Z have the same cost; and Systems C and Y have the same cost.

Table 16

DISACT LIFE CYCLE COST SUMMARY
(Dollars in Thousands)

	COMPONENT SYSTEM X			COMPONENT SYSTEM Y			COMPONENT SYSTEM Z			TOTAL
	EQPMNT	MANPWR	TOTAL	EQPMNT	MANPWR	TOTAL	EQPMNT	MANPWR	TOTAL	COST
LIFE CYCLE COST	26958.9	14296.4	41255.3	42326.6	153304.4	195631.0	22416.4	75028.1	97444.5	334330.8
TTL DEVELPMNT COST	2269.2	4717.9	6987.1	1421.0	4756.6	6177.6	1424.7	3904.2	5328.9	18493.6
SYS RESEARCH	0.0	369.1	369.1	0.0	369.1	369.1	0.0	369.1	369.1	1107.3
ENG DEVELPMNT	0.0	800.0	800.0	0.0	800.0	800.0	0.0	800.0	800.0	2400.0
PROTOTYPE SYS	1310.0	700.0	2010.0	599.0	957.5	1556.5	756.0	372.4	1128.4	4694.9
SFTWARE DEV	0.0	2049.8	2049.8	0.0	2049.8	2049.8	0.0	2049.8	2049.8	6149.4
SYS DOCUMNTATION	410.0	0.0	410.0	410.0	0.0	410.0	410.0	0.0	410.0	1230.0
SYS TEST+EVAL	247.7	743.0	990.7	178.5	535.4	713.9	89.4	268.1	357.5	2062.1
TRAINING	0.0	56.0	56.0	0.0	44.8	44.8	0.0	44.8	44.8	145.6
MATERIEL SUP	301.5	0.0	301.5	233.5	0.0	233.5	169.3	0.0	169.3	704.3
TTL INVESTMNT COST	17907.4	2368.8	20276.2	15515.2	1275.6	16790.8	6963.7	1186.8	8150.5	45217.5
ADPE PROC	12842.0	0.0	12842.0	9600.0	0.0	9600.0	4350.0	0.0	4350.0	26792.0
SYS SFTWARE PROC	642.1	0.0	642.1	960.0	0.0	960.0	435.0	0.0	435.0	2037.1
SFTWARE DEV	0.0	1038.0	1038.0	0.0	1038.0	1038.0	0.0	1038.0	1038.0	3114.0
TEMPEST SECURITY	1926.3	0.0	1926.3	1440.0	0.0	1440.0	652.5	0.0	652.5	4018.8
SYS DOCUMNTATION	207.6	0.0	207.6	207.6	0.0	207.6	207.6	0.0	207.6	622.8
FILE CONVERSION	0.0	0.0	0.0	210.0	0.0	210.0	0.0	0.0	0.0	210.0
FACILITIES ACTIV	655.2	280.8	936.0	554.4	237.6	792.0	347.2	148.8	496.0	2224.0
TRAINING	350.0	1050.0	1400.0	1583.2	0.0	1583.2	536.4	0.0	536.4	3519.6
MATERIEL SUP	1284.2	0.0	1284.2	960.0	0.0	960.0	435.0	0.0	435.0	2679.2
TTL OPERATING COST	6782.3	7209.7	13992.0	25390.4	147272.2	172662.6	14028.0	69937.1	83965.1	270619.7
SYS MGT+OPS	0.0	0.0	0.0	0.0	109765.0	109765.0	0.0	48167.0	48167.0	157932.0
ADPE MAINT	0.0	1284.2	1284.2	0.0	12930.0	12930.0	0.0	9465.0	9465.0	23679.2
SFTWARE MAINT	0.0	1928.0	1928.0	0.0	1928.0	1928.0	0.0	1928.0	1928.0	5784.0
DOCUMENTATION	385.6	0.0	385.6	385.6	0.0	385.6	385.6	0.0	385.6	1156.8
FACILITIES SUP	0.0	637.5	637.5	0.0	18849.2	18849.2	0.0	9089.7	9089.7	28576.4
TRAINING	840.0	3360.0	4200.0	950.0	3800.0	4750.0	321.8	1287.4	1609.2	10559.2
MATERIEL SUP	1146.3	0.0	1146.3	19644.3	0.0	19644.3	8910.1	0.0	8910.1	29700.7
COMMUNICATIONS	4410.4	0.0	4410.4	4410.5	0.0	4410.5	4410.5	0.0	4410.5	13231.4

Table 17

DISACT LIFE CYCLE COST SCHEDULE
(Dollars in Thousands)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
LIFE CYCLE COST	1623.7	5664.3	7066.4	17329.3	48176.2	34986.0	27435.8	27435.8	27435.6	27435.6
TTL DEVELPMNT COST	1623.7	5664.3	7066.4	4139.2	0.0	0.0	0.0	0.0	0.0	0.0
SYS RESEARCH	442.9	332.2	221.5	110.7	0.0	0.0	0.0	0.0	0.0	0.0
ENG DEVELPMNT	0.0	720.0	960.0	720.0	0.0	0.0	0.0	0.0	0.0	0.0
PROTOTYPE SYS	0.0	1878.0	2816.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SFTWARE DEV	984.0	1721.8	1721.8	1721.8	0.0	0.0	0.0	0.0	0.0	0.0
SYS DOCUMNTATION	196.8	344.4	344.4	344.4	0.0	0.0	0.0	0.0	0.0	0.0
SYS TEST+EVAL	0.0	412.5	618.6	1031.0	0.0	0.0	0.0	0.0	0.0	0.0
TRAINING	0.0	58.2	87.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MATERIEL SUP	0.0	197.2	295.8	211.3	0.0	0.0	0.0	0.0	0.0	0.0
TTL INVESTMNT COST	0.0	0.0	0.0	13190.1	21114.0	7923.8	373.7	373.7	373.7	373.7
ADPE PROC	0.0	0.0	0.0	8037.6	13396.0	5358.4	0.0	0.0	0.0	0.0
SYS SFTWARE PROC	0.0	0.0	0.0	611.1	1018.6	407.4	0.0	0.0	0.0	0.0
SFTWARE DEV	0.0	0.0	0.0	0.0	311.4	311.4	311.4	311.4	311.4	311.4
TEMPEST SECURITY	0.0	0.0	0.0	1205.6	2009.4	803.8	0.0	0.0	0.0	0.0
SYS DOCUMNTATION	0.0	0.0	0.0	0.0	62.2	62.2	62.3	62.3	62.3	62.3
FILE CONVERSION	0.0	0.0	0.0	105.0	105.0	0.0	0.0	0.0	0.0	0.0
FACILITIES ACTIV	0.0	0.0	0.0	667.2	1112.0	444.8	0.0	0.0	0.0	0.0
TRAINING	0.0	0.0	0.0	1759.8	1759.8	0.0	0.0	0.0	0.0	0.0
MATERIEL SUP	0.0	0.0	0.0	803.8	1339.6	535.8	0.0	0.0	0.0	0.0
TTL OPERATING COST	0.0	0.0	0.0	0.0	27062.2	27062.2	27062.1	27062.1	27061.9	27061.9
SYS MGT+OPS	0.0	0.0	0.0	0.0	15793.2	15793.2	15793.2	15793.2	15793.2	15793.2
ADPE MAINT	0.0	0.0	0.0	0.0	2368.0	2368.0	2367.9	2367.9	2367.9	2367.9
SFTWARE MAINT	0.0	0.0	0.0	0.0	578.4	578.4	578.4	578.4	578.4	578.4
DOCUMENTATION	0.0	0.0	0.0	0.0	115.6	115.6	115.7	115.7	115.7	115.7
FACILITIES SUP	0.0	0.0	0.0	0.0	2857.7	2857.7	2857.7	2857.7	2857.6	2857.6
TRAINING	0.0	0.0	0.0	0.0	1056.0	1056.0	1055.9	1055.9	1055.9	1055.9
MATERIEL SUP	0.0	0.0	0.0	0.0	2970.1	2970.1	2970.1	2970.1	2970.1	2970.1
COMMUNICATIONS	0.0	0.0	0.0	0.0	1323.2	1323.2	1323.2	1323.2	1323.1	1323.1

Table 17 (Concluded)

	1988	1989	1990	1991	TOTAL LCC
LIFE CYCLE COST	27435.6	27435.5	27435.5	27435.5	334330.8
TTL DEVELPMNT COST	0.0	0.0	0.0	0.0	18493.6
SYS RESEARCH	0.0	0.0	0.0	0.0	1107.3
ENG DEVELPMNT	0.0	0.0	0.0	0.0	2400.0
PROTOTYPE SYS	0.0	0.0	0.0	0.0	4694.9
SFTWARE DEV	0.0	0.0	0.0	0.0	6149.4
SYS DOCUMNTATICN	0.0	0.0	0.0	0.0	1230.0
SYS TEST+EVAL	0.0	0.0	0.0	0.0	2062.1
TRAINING	0.0	0.0	0.0	0.0	145.6
MATERIEL SUP	0.0	0.0	0.0	0.0	704.3
TTL INVESTMNT COST	373.7	373.7	373.7	373.7	45217.5
ADPE PROC	0.0	0.0	0.0	0.0	26792.0
SYS SFTWARE PROC	0.0	0.0	0.0	0.0	2037.1
SFTWARE DEV	311.4	311.4	311.4	311.4	3114.0
TEMPEST SECURITY	0.0	0.0	0.0	0.0	4018.8
SYS DOCUMNTATICN	62.3	62.3	62.3	62.3	622.8
FILE CONVERSION	0.0	0.0	0.0	0.0	210.0
FACILITIES ACTIV	0.0	0.0	0.0	0.0	2224.0
TRAINING	0.0	0.0	0.0	0.0	3519.6
MATERIEL SUP	0.0	0.0	0.0	0.0	2679.2
TTL OPERATING COST	27061.9	27061.8	27061.8	27061.8	270619.7
SYS MGT+OPS	15793.2	15793.2	15793.2	15793.2	157932.0
ADPE MAINT	2367.9	2367.9	2367.9	2367.9	23679.2
SFTWARE MAINT	578.4	578.4	578.4	578.4	5784.0
DOCUMENTATION	115.7	115.7	115.7	115.7	1156.8
FACILITIES SUP	2857.6	2857.6	2857.6	2857.6	28576.4
TRAINING	1055.9	1055.9	1055.9	1055.9	10559.2
MATERIEL SUP	2970.1	2970.0	2970.0	2970.0	29700.7
COMMUNICATIONS	1323.1	1323.1	1323.1	1323.1	13231.4

a. ADPE Procurement

The projected ADPE procurement cost is estimated to be $26,792,000, or approximately 59% of the total investment cost. It is assumed that this cost will be incurred beginning in the fourth year (to have the initial IOC at the beginning of the fifth year) and continue through the fifth and sixth years according to the following schedule: 30% for Year 4, 50% for Year 5, and 20% for Year 6.

ADPE procurement cost was estimated on the basis of direct manufacturer quotations of present systems with similar generic capabilities as those contained in the component ADPS configurations in DISACT. Table 12, introduced previously, presents the cost breakdown of individual system elements that SRI compiled from discussions with numerous manufacturers.[17] It should also be stated that the costs presented for the component systems in Table 12 represent the cost of "militarized" or "ruggedized" systems, and they are quoted for a quantity purchase of one.

The extrapolation premise that SRI used to project the cost of the ADPE 5 years from now was that the present day prices would be reduced by half for quantity purchases (on the order of 100 or more) such as those that would be required for the DISACT concept. On that basis, the actual figures used in the LCC model were:

- System X ($60K)--quantity of 234 (20 of which were already purchased as prototype systems).
- System Y ($300K)--quantity of 33 (1 of which was already purchased as a prototype system).
- System Z ($150K)--quantity of 31 (2 of which were already purchased as prototype systems).

b. System Software Procurement Cost

The projected system software procurement cost is estimated to be $2,037,100, or approximately 5% of the total investment cost. It is assumed that this cost will be incurred beginning in the fourth year and will parallel the ADPE procurement schedule of: 30% for Year 4, 50% for Year 5, and 20% for Year 6.

System software procurement cost was estimated on the basis of ratios of similar cost categories contained in the LCC estimates found in References 11 and 13. Specifically, system software procurement cost was calculated to be 5% of the ADPE procurement cost element for System X and 10% of the ADPE procurement cost element for System Y and System Z.

c. Software Development Cost

The projected software development cost is estimated to be $3,114,000, or approximately 7% of the total investment cost. It is assumed that this cost will be incurred continuously during the operational lifetime of DISACT according to a schedule of 10% per year for 10 years.

Software development cost was estimated on the basis of providing the following complement of personnel to work on development tasks:

- 12 senior analyst/programmers ($34K/year)
- 5 senior systems programmers ($36K/year)
- 3 ADPE operators ($20K/year)
- 1 ADPE maintenance man ($21K/year).

SRI assumed that only 35% of this complement would be engaged in actual software development (the other 65% of effort being expended for software maintenance). However, the total personnel costs were inflated by 33% to account for extra personnel who would supplement those listed above to maintain a full staff during the entire working year, (that is, fill in for personnel on leave, and so on). In effect then, the costs reflect a staff of 28 rather than 21. The total software development cost was equally distributed among the three component systems as an initial estimate.

d. TEMPEST Security

The projected TEMPEST security cost is estimated to be $3,609,000, or approximately 9% of the total investment cost. It is assumed that it will be incurred concurrently with the ADPE procurement schedule of: 30% for Year 4, 50% for Year 5, and 20% for Year 6.

TEMPEST security cost was estimated on the basis of SRI consultations with experienced TEMPEST engineers. Specifically, the cost was placed at 15% of the ADPE procurement cost element. This overall estimate is based on the assumption that a variety of least-cost concepts, including shelters and equipment modifications, would be used.

e. System Documentation Cost

The projected system documentation cost is estimated to be $622,800, or approximately 1% of the total investment cost. It is assumed that this cost will be incurred continuously during the operational lifetime of DISHIER according to a schedule of 10% per year for 10 years.

System documentation cost was estimated, on the basis of SRI experience, to be 20% of the software development cost. The total system documentation cost was equally distributed among the three component systems as an initial estimate.

f. File Conversion Cost

The projected file conversion cost is estimated to be $210,000, or approximately 0.5% of the total investment cost. It is assumed that this cost will be incurred at the time of initial implementation of DISACT as an operational system; hence, it has been assigned the following schedule: 50% for Year 4 and 50% for Year 5.

File conversion cost was estimated on the basis of an SRI estimate that it would take approximately 7.5 man-years of analyst/programmer effort ($28K/year) to complete the required file conversions. In this estimate, SRI assumed that 6 man-months would be adequate per system, and that there was a maximum of 15 systems whose files must be converted.

g. Facilities Activation Cost

The projected facilities activation cost is estimated to be $2,224,000, or approximately 5% of the total investment cost. It is assumed that this cost will be incurred concurrently with the ADPE procurement schedule of: 30% for Year 4, 50% for Year 5, and 20% for Year 6.

Facilities activation cost was estimated on the basis of information assembled from References 11 and 13. Specifically, each System X activation was assumed to cost $4K, and each System Y and System Z activation was assumed to cost $8K. Additionally, provision was made for each System Z to have one shelter at a cost of $8K, and each System Y to have two shelters at a cost of $16K per system.

h. Training Cost

The projected training cost is estimated to be $3,519,600, or approximately 8% of the total investment cost. It is assumed to be incurred to coincide with the initial operating capability of the ADPE; hence, it follows the schedule: 50% for Year 4 and 50% for Year 5.

Training cost was estimated on the basis of the number of personnel who would: (1) be involved in the operations and maintenance of the ADPE, and (2) be involved in the use of the ADPE. References 7, 11 and 13, as well as direct quotations from ADPE manufacturers, indicated that the cost of a week of training was approximately $700 over and above the billet costs of 757 Marines involved in ADP. Based on SRI's estimate of the number of weeks required to train individual skill types (see Appendix A), a representative figure of 4 weeks was chosen for all operations and maintenance positions; therefore, SRI accounted a cost of $2800 per individual trained in ADP operations and maintenance. SRI further estimated that 1 week was sufficient to train functional and administrative users of the ADPE. The number of users was estimated at 2000.

i. Materiel Support Cost

The projected materiel support cost is estimated to be $2,679,200, or approximately 6% of the total investment cost. It is assumed that this cost will be incurred at the time of ADPE procurement according to the schedule: 30% for Year 4, 50% for Year 5, and 20% for Year 6.

Materiel support cost was estimated on the basis of ratios of similar cost categories contained in the LCC estimates found in

References 11 and 13. Specifically, materiel support cost was calculated to be 10% of the ADPE procurement cost element.

3. DISACT Operating Cost

As shown in Table 16, the projected operating cost for DISACT is $270,619,700. This projection is based on analysis of typical operating costs for ADPS configurations, with the following assumptions:

- The operational lifetime of the system will be 10 years from the IOC of the first systems to be fielded.
- Operating costs will be incurred continuously during the operational lifetime according to a schedule of 10% per year for 10 years.

The component cost elements of the total operating cost are addressed in the paragraphs below.

a. System Management and Operations

The projected system management and operations cost is estimated to be $157,932,000, or approximately 58% of the total operating cost.

System management and operations cost was estimated as the product of the 633 analyst/programmers, systems programmers, and ADPE operators that would be required to staff the DISACT ADP systems, and their billet costs as identified in Table 13, introduced previously. Billet costs were taken from Reference 4 and adjusted to make that data current to 1977. Billet costs contain all salary and burden costs that can be ascribed to the LCC of each Marine of a particular rank and occupational specialty.

b. ADPE Maintenance Cost

The projected ADPE maintenance cost is estimated to be $23,679,200, or approximately 8% of the total operating cost.

One portion of the ADPE maintenance cost was estimated as the product of the 96 ADPE maintenance men who would be required

to staff the DISACT ADP systems, and the associated cost of each ADPE maintenance billet, also shown in Table 13. The second portion was estimated on the basis of a contractor maintenance cost of 1% per year for 10 years.

c. Software Maintenance Cost

The projected software maintenance cost is estimated to be $5,784,000, or approximately 2% of the total operating cost.

Software maintenance cost was estimated on the basis of providing the following complement of personnel to work on development tasks:

- 12 senior analyst/programmers ($34K/year)
- 5 senior systems programmers ($36K/year)
- 3 ADPE operators ($20K/year)
- 1 ADPE maintenance man ($21K/year).

SRI assumed that only 65% of this complement would be engaged in actual software maintenance (the other 35% of effort being expended for software development). However, the total personnel costs were inflated by 33% to account for extra personnel who would supplement those listed above to maintain a full staff during the entire working year, (that is, fill in for personnel on leave, and so on). In effect then, the costs reflect a staff of 28 rather than 21. The total software maintenance cost was equally distributed among the three component systems as an initial estimate.

d. Documentation Cost

The projected documentation cost is estimated to be $1,156,800, or approximately 0.4% of the total operating cost.

Documentation cost was estimated on the basis of SRI experience, to be 20% of the software maintenance cost element. The total documentation cost was equally distributed among the three component systems as an initial estimate.

e. Facilities Support Cost

The projected facilities support cost is estimated to be $28,576,400, or approximately 11% of the total operating cost.

Facilities support cost was estimated on the basis of ratios of a similar cost category contained in the LCC estimates of Reference 13. Specifically, facilities support cost was calculated to be 15% of the combined costs of the software development, system management and operations, ADPE maintenance, and software maintenance cost elements.

f. Training Cost

The projected training cost is estimated to be $10,559,200, or approximately 4% of the total operating cost.

Training cost was estimated on the basis of an SRI estimate of an approximate 30% yearly turnover in ADP job categories; hence, it was calculated to be 30% of the training cost element (accounted under the investment cost) per year for the 10-year lifetime.

g. Materiel Support Cost

The projected materiel support cost is estimated to be $29,700,700, or approximately 11% of the total operating cost.

Materiel support cost was estimated on the basis of ratios of similar cost categories contained in the LCC estimates found in References 11 and 13. Specifically, materiel support cost was calculated to be 5% of the ADPE Procurement cost element for spares and repair parts plus 17% of the combined costs of the system management and operations, software maintenance, and software development cost elements for supplies.

h. Communications Cost

The projected communications cost is estimated to be $13,231,400, or approximately 5% of the total operating cost.

Communications cost was estimated on the basis of ratios of a similar cost category contained in the LCC cost estimates of

Reference 13. Specifically, communications cost was calculated to be 4% of the total DISHIER LCC. The total communications cost was equally distributed among the three component systems as an initial estimate.

4. Cost Perspectives

As a means of summarizing, interpreting, and ascertaining the importance of various elements and components of the DISACT LCC, two additional pieces of information are presented in Table 18 and Figure 9. Table 18 addresses the relative impact on the DISACT LCC of the three LCC phases, and three component systems, the manpower and equipment resources. Figure 9 graphically presents the profile of annual expenditures required to develop, operate, and maintain the DISACT concept over its life cycle.

Table 18

DISACT COST ELEMENT PERSPECTIVES

Cost Element	Percent of DISACT LCC
LCC Phases	
• Development	5.5%
• Investment	13.5
• Operations	81.0
Component Systems	
• System X	12.3
• System Y	58.5
• System Z	29.1
Resources	
• Equipment	27.4
• Manpower	72.6

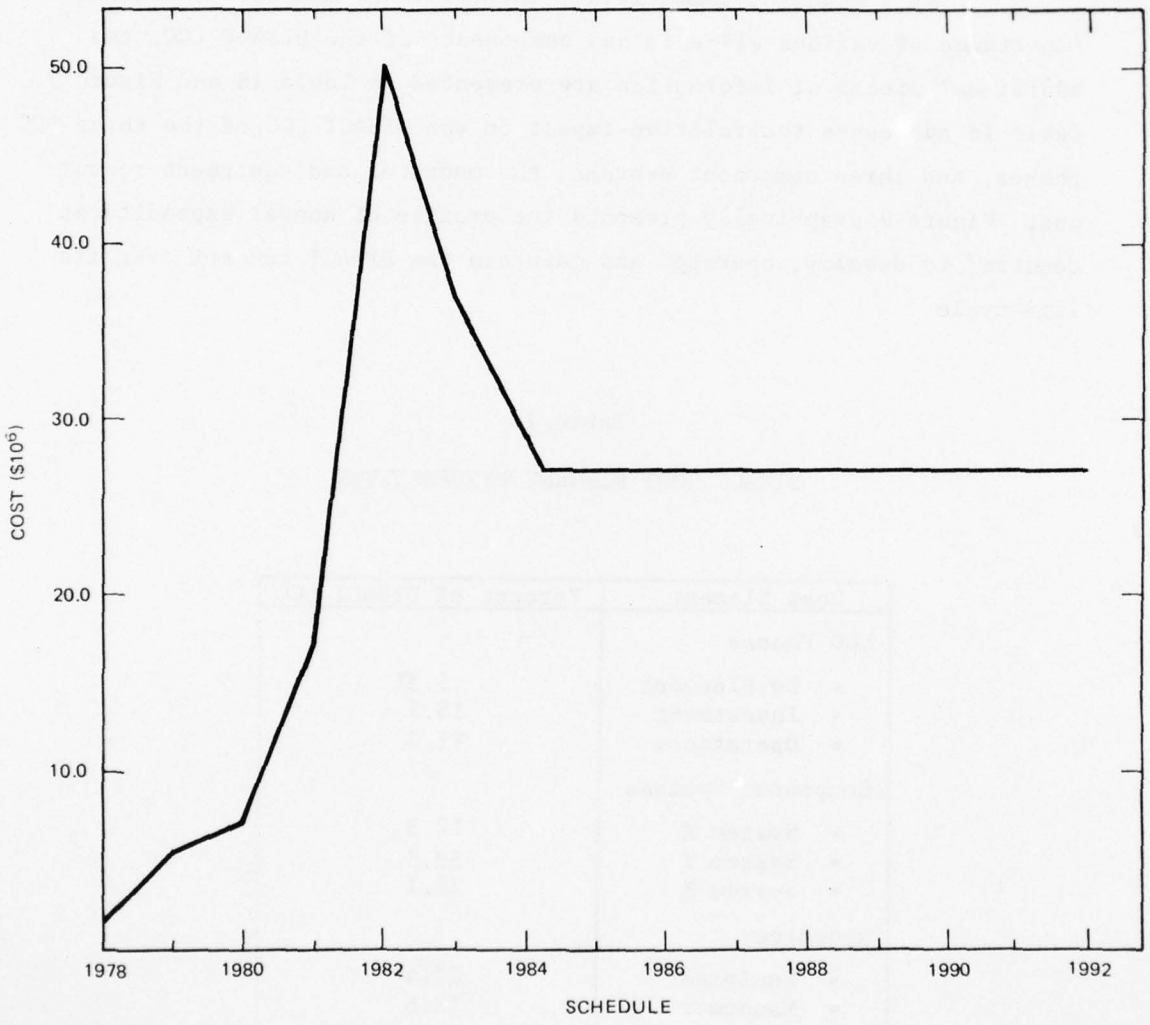

FIGURE 9 ANNUAL DISACT LCC EXPENDITURES

Appendix A

ADP TRAINING REQUIREMENTS

Appendix A

ADP TRAINING REQUIREMENTS

Appendix B of Volume IV of this study identified and described the job stereotypes that SRI envisions will be required to staff the 1980 ADPS concepts. The job stereotypes are:

- ADPE operator
- Analyst/programmer
- Senior analyst/programmer
- Systems programmer
- Senior systems programmer
- ADPE maintenance man.

Each of these job stereotypes is addressed below with respect to the training it will require. To facilitate that discussion, it will be a premise that three basic sizes of component computer systems will be used in the 1980 ADPS alternative (as has been discussed in the Sections IV and V); these will be referred to generically as the standalone system, the middle size system, and the large size system.

ADPE Operator

In the concepts that SRI has described, ADPE operators are required to staff the middle size (MS) system and the large size (LS) system; therefore, the following two positions will have training requirements as follows:

- ADPE operator (MS)--1 week orientation with standalone device or experience with standalone devices, plus 2 weeks training and familiarization with the middle size system.
- ADPE operator (LS)--3 weeks training and familiarization with the large size system including all peripherals, plus experience on the other two systems.

Analyst/programmer

Analyst/programmers are required to staff the middle size system and the large size system; therefore, the following two positions will have training requirements as follows:

- Analyst/programmer (MS)--1 week hardware familiarization or previous experience, plus a basic (beginning) programming course and/or experience (on any system), plus 3 weeks utility and application program training (1 week each for system/utility, applications, editor).
- Analyst/programmer (LS)--Same as analyst/programmer (MS).

Senior Analyst/programmer

Senior analyst programmers are assigned at upper echelons only. Their training must include at least 1-2 years experience as analyst/programmers plus 4 weeks of advanced courses, in application languages and analysis and application techniques.

Systems programmer

Systems programmers are required to staff the middle size system and the large size system; therefore, the following two positions will have training requirements as follows:

- Systems programmer (MS)--Experience as an analyst/programmer on the middle size system, plus 2 weeks operating system orientation, plus 1 week high level languages orientation, plus 1 week hardware orientation.
- Systems programmer (LS)-- Experience as an analyst/programmer on the large size system, experience as a systems programmer (MS), or other equivalent system experience, plus 2 weeks orientation in operating system and utilities, plus 2 weeks orientation in compilers and analysis packages, plus 2 weeks hardware, peripheral, and communications familiarization.

Senior Systems Programmer

Senior systems programmers are assigned at upper echelons only. Their training must include at least 1-2 years experience as a systems programmer (LS), plus advanced courses in operating system software and macro- or high-level languages used in supported units.

ADPE Maintenance Man

ADPE maintenance men are assigned at upper echelons only, but they must also serve the needs of lower echelon systems as appropriate. Based on the number of different ADPE components contained in the various component ADP systems, SRI estimates that approximately 4-6 weeks of formal courses in ADPE maintenance are required. This must then be supplemented by on-the-job training with the particular system to which the man is assigned.

Appendix B

ADPE PROCUREMENT TRADEOFFS

Appendix B

ADPE PROCUREMENT TRADEOFFS

A subject of major interest throughout the study was the applicability of "off-the-shelf" ADPE to the Marine Corps environment. There were two primary reasons for this interest. The first was an anticipated reduction in the investment required for ADPE since it was well known that ADPE built specifically for the military environment typically initially cost two to five times as much as comparable ADPE serving the commercial market. The second was an anticipated reduction in the time that would be needed to develop and field an ADPS--the development cycle for specialized military ADPE typically extends the research and development phase of the acquisition by a number of years.

During the course of the study, the term "off-the-shelf" has come to have a somewhat different meaning than it did even 2 years ago. Several ADPE manufacturers have developed a product line designed specifically for military applications, and in most cases these are fully compatible with the commercial counterparts on which they are based, and with which they share a common software base. Therefore, when one speaks of "off-the-shelf" one now has the choice of several grades: commercial, ruggedized or militarized, and milspec. The basic differences result from the redundancy and packaging that is incorporated in each grade.

In terms of tradeoffs, the question becomes: Can the expense of the more rugged militarized systems be overcome through the card-replacement maintainability of the commercial grade systems without a compromise in system availability? SRI has asked this question at every opportunity during the course of this study, but no hard conclusions appear warranted since there is little quantitative basis for any decision.

Certainly the SDA test results have shown that commercial grade ADPE has satisfied the FMF environmental requirements during the relatively short time that they were exercised, but that experience is not sufficient

to make general reliability and maintainability conclusions. For this reason, SRI has pursued a somewhat middle course by presenting in the LCC analysis the cost of militarized or ruggedized "off-the-shelf" ADPE to fulfill the requirements of the alternative ADPS concepts.

To show the potential cost benefit of procuring commercial ADPE rather than militarized ADPE, however, SRI has constructed Table B-1. Table B-1 shows the cost savings involved for the two alternative ADPS concepts DISHIER and DISACT, and relates these savings to the overall reduction in the LCC for these concepts. The results from Table B-1 should be viewed only as an upper bound, however, of the potential cost benefits that could accrue. No assumptions are made regarding the extra spare parts or maintenance activity that the commercial ADPE might require over and above that which would be required by the militarized ADPE, and such considerations could only diminish the potential cost benefit--or even reverse it.

The results of SRI's discussions concerning ADPE reliability and maintenance with computer system manufacturers and vendors (both strictly commercially-oriented companies and those with long-time military application experience) are, likewise, inconclusive. It is generally agreed that milspec ADPE results in better components and greater reliability; and, in a non-benign environment, the temperature, vibration, and shock effect will be reduced significantly. In a benign environment, however, commercial ADPE reliability is just about as good as that of milspec ADPE. It was pointed out that one cannot quantify the reduction in reliability incurred by commercial ADPE ADPE in a non-benign environment versus militarized ADPE in the same environment unless that environment is defined rather precisely.

Another aspect of the technology in the post-1980 timeframe that affects the maintenance of ADPE is the trend toward simple replacement of

Table B-1

EFFECT OF COMMERCIAL ADPE ON LCC
(Dollars in Thousands)

Alternative ADPS Concept	Procurement Cost for Militarized ADPE	Percent of LCC Cost	Procurement Cost for Commercial ADPE	Percent of LCC Cost	Maximum Cost Savings
DISHIER	$25,860.0	10.56%	$12,930.0	5.58%	$12,930.0
DISACT	28,590.0	8.1	14,295.0	4.05	14,295.0

ADPE component cards by military personnel in event of failure. Milspec ADPE results, however, in highly specialized design, and such ADPE may need service assistance that can only be provided by highly experienced maintenance personnel. Therefore, although the need for maintenance may be less frequent in milspec ADPE, it may require a higher skill level.

There are also secondary reliability problems that arise in milspec ADPE from the act of meeting requirements. For example, milspec boards may be coated to keep out moisture. If they crack or need to be removed, they may be the source of future reliability problems themselves, since the coating may, in fact, trap moisture if it is once allowed into the components. Hence, the maintenance cost of milspec ADPE may be more expensive in certain circumstances.

Estimates of the reliability of commercial, ruggedized, and milspec ADPE were all quite high. The marginal benefit for milspec versus ruggedized ADPE in a military environment, for example, was estimated to be in the neighborhood of approximately .98 for milspec and .95 for ruggedized. That is, the mean time between failures (MTBF) is very high in either case. Commercial ADPE reliability in military environments were considered somewhat lower, but they were equally high in a benign environment.

In summary, there are arguments advocating commercial, ruggedized, and milspec ADPE, but there is little hard quantitative evidence of a complete systems nature available on which to base decisions. There appears to be a slight majority of opinion favoring the use of ruggedized or commercial ADPE with more spare card component replacements over completely milspec ADPE. This is strongly true in benign environments, but perhaps slightly reversed in non-benign environments characterized by high heat, significant vibration, or significant shock. There is growing support for ADPS configurations having a mixed complement of ADPE, some of which is commercial and some of which is ruggedized or milspec, to accommodate a

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spectrum of potential environments. This would, however, impact the logistics supply problem and the flexibility of all system components to mobilize.

It was strongly recommended by all parties contacted that before making a final decision between commercial versus militarized ADPE one must very carefully evaluate the application and operational environment. A premature decision can have significant consequences with regard to the overall life cycle cost and the ultimate reliability of the system.

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